Chagrin River Watershed Action Plan

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Endorsement of Plan by Watershed Stakeholders

This Plan was adopted by the Chagrin River Watershed Board of Trustees. This Board represents local governments and park districts in the Chagrin River Watershed. This plan was fully endorsed by the Ohio Environmental Protection Agency and Ohio Department of Natural Resources on December 18, 2006. This Plan was revised in December 2009 and submitted to Ohio Environmental Protection Agency and Ohio Department of Natural Resources on January 15, 2010. CRWP completed Plan updates in September 2011 to provide additional details on subwatersheds in non attainment of water quality standards.

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G. List of Acronyms

305(b)	Ohio Environmental Protection Agency Water Quality Report
319	Section 319 of the Clean Water Act
BGI	Balanced Growth Initiative
BMP	Best Management Practices
CCBH	Cuyahoga County Board of Health
CFS	Cubic Feet per Second
CPP	Continuing Planning Process
CRWP	Chagrin River Watershed Partners
CWA	Clean Water Act
CWH	Coldwater Habitat
CWI	Chagrin Watershed Institute
ERU	Equivalent Residential Unit
EWH	Exceptional Warm Water Habitat
FEMA	Federal Emergency Management Agency
GCGHD	Geauga County General Health District
GIS	Geographic Information System
GLC	Great Lakes Commission
GPD	Gallons Per Day
GPM	Gallons Per Minute
HB	House Bill
HHEI	Headwater Habitat Evaluation Index
HSTS	Household Sewage Treatment Systems
HUC #	Hydrologic Unit Code Number
IBI	Index of Biotic Integrity
ICI	Invertebrate Community Index
IDDE	Illicit Disharge Detection & Elimination
LCGHD	Lake County General Health District
LCSMD	Lake County Stormwater Management Department
LEPF	Lake Erie Protection Fund
LPA	Land Protection Agencies
MiWB	Modified Index of Well Being
MS4	Municipal Separate Storm Sewer Systems
NASA	National Aeronautics and Space Administration
NEFCO	Northeast Ohio Four County Regional Planning and Development Organization
NEORSD	Northeast Ohio Regional Sewer District
NOACA	Northeast Ohio Areawide Coordinating Agency
NPDES	National Pollution Discharge Elimination System
NPS	Non Point Source Pollution
NRCS	Natural Resource Conservation Service
OCAP	Ohio Capability Analysis Project
ODNR	Ohio Department of Natural Resources
Ohio EPA	Ohio Environmental Protection Agency
OLEC	Ohio Lake Erie Commission
PCCHD	Portage County Combined General Health District
POS	Point of Sale
QHEI	Qualitative Habitat Evaluation Index
RM	River Mile
SSH	Seasonal Salmonid Habitat
SWCD	Soil & Water Conservation District
TMDL	Total Maximum Daily Load
USEPA	United States Environmental Protection Agency
USGS	United States Geological Society
WMSC	Water Management and Sediment Control
WQM	Water Quality Management
WRLC	Western Reserve Land Conservancy
WWH	Warmwater Habitat
WWTP	Wastewater Treatment Plant

1 Chagrin River Watershed

The Chagrin River watershed drains 267 square miles in four Northeast Ohio counties. Portions of twenty two municipalities, ten townships, and four park districts govern land use and other activities in the watershed. The Main Branch of the Chagrin River begins above Bass Lake in the City of Chardon and flows 48 miles before entering Lake Erie in the City of Eastlake. Along its path, the Main Branch is joined by the Aurora Branch, flowing from the Mantua Township and Aurora and meeting the Main Branch in Bentleyville, and the East Branch, beginning in Geauga County and joining the Main Branch in Willoughby. The watershed is experiencing significant development pressure as the Cleveland population continues to migrate from the urban core and inner ring communities to outlying suburbs. However, the majority of the river retains its riparian forest cover and nearly fifty percent (50%) of the land in the watershed is zoned for low density, large lot residential uses. The river valley offers a diversity of terrestrial and aquatic communities, wildlife, unique rock outcroppings, and extensive headwater wetlands.

Figure 1: Chagrin River Counties

Figure 2: Chagrin River Communities

1.1 Administrative Boundaries

The Chagrin River and its tributaries flow through four counties and thirty-seven communities. The tables below detail if the community is a member of the Chagrin River Watershed Partners, Inc. (CRWP), the percentage of community in the watershed, and if the entity is designated under NPDES Phase II.

Table 1: Counties in the Chagrin Watershed

County	Percentage of County in Watershed	CRWP Member
Cuyahoga County	21%	No
Geauga County	51%	Yes
Lake County	20%	Yes
Portage County	8%	No

Table 2: Municipalities in the Chagrin Watershed

Municipality	CRWP Member	Phase II	% in Watershed
City of Aurora	Yes	Yes	54.6%
City of Beachwood	No	Yes	17.4%
City of Chardon	Yes	No	47.5%
City of Eastlake	Yes	Yes	52.6%
City of Highland Heights	No	Yes	9.3%
City of Kirtland	Yes	Yes	100%
City of Mayfield	Yes	Yes	91.7%
City of Mayfield Heights	Yes	Yes	78.8%
City of Mentor	Yes	Yes	34.6%
City of Pepper Pike	Yes	Yes	92.8%
City of Solon	Yes	Yes	40.8%
City of Streetsboro	No	Yes	0.3%
City of Wickliffe	Yes	Yes	20.4%
City of Willoughby	Yes	Yes	71.3%
City of Willoughby Hills	Yes	Yes	75.5%
Village of Bentleyville	Yes	Yes	17.4%
Village of Chagrin Falls	Yes	Yes	100%
Village of Gates Mills	Yes	Yes	100%
Village of Hunting Valley	Yes	No	100%
Village of Kirtland Hills	Yes	No	90.3%
Village of Moreland Hills	Yes	Yes	100%
Orange Village	Yes	Yes	53.5%
Village of South Russell	Yes	Yes	100%
Waite Hill Village	Yes	No	100%
Village of Woodmere	Yes	Yes	100%

Table 3: Townships in Chagrin Watershed

Township	CRWP Member	Phase II	% in Watershed
Auburn Township	Yes	No	17.8%
Bainbridge Township	Yes	Yes	96.4%
Chagrin Falls Township	Yes	No	100%
Chardon Township	Yes	No	65.2%
Chester Township	Yes	Yes	100%
Claridon Township	Yes	No	2.9%
Concord Township	No	No	0.1%
Mantua Township	Yes	No	27.5%
Munson Township	Yes	No	84.2%
Newbury Township	Yes	No	65.2%
Russell Township	Yes	Yes	100%
Shalersville Township	No	No	0.8%

Table 4: Park Districts in Chagrin Watershed

Park District	CRWP Member
Cleveland Metroparks	Yes
Geauga Park District	Yes
Lake Metroparks	Yes
Portage Park District	No

1.2 History of Chagrin River Watershed

On a 1755 map, the Chagrin River was labeled as the Elk River. The name "Chagrin" has been claimed to come from two different sources. One source claims that the river name Shaguin memorialized a French trader named Sieur de Saguin. Another hypothesis is that the name came from the Indian word "shagrin" meaning "clear water". Regardless of the origin of the name, it was anglicized in 1797 on a map of the Western Reserve prepared by Seth Pease to read "Chagrin River". Land use has been changing in the Chagrin River valley since the settlers first arrived in the 1700's. These families cleared forests and drained wetlands to build farms and villages. The Chagrin River was used for mills in these early days. In spite of massive clearing and continued farming, residential, commercial and industrial development, the Chagrin River maintains high water quality and natural beauty.

1.3 Scenic River Designation

Seventy-one miles of the Chagrin River have been designated as a State Scenic River. The original designation of 49 miles includes the Aurora Branch from S.R. 82, 12 miles downstream to its confluence with the main stem of the Chagrin, 23 miles of the main stem from its confluence with the Aurora Branch downstream to US Rt. 6, and 15 miles of the East Branch from Heath Road Bridge downstream to its confluence with the main stem was made in 1979. The river's Scenic designation was extended in November 2002 to include the headwaters of the Chagrin, also known as the Upper Chagrin from the Woodiebrook Road bridge to the confluence with the Aurora Branch of the Chagrin River in Bentleyville. Scenic designated reaches of the river are characterized by exceptional aquatic habitat and adjacent high quality forests. Figure 3 shows the scenic river sections of the Chagrin River highlighted in yellow.

Figure 3: Scenic River Portions of Chagrin

1.4 Demographics and Economic Trends

A significant factor influencing the Chagrin River watershed is the continuing dispersal of people and jobs from Cuyahoga County to the undeveloped areas of the Chagrin River watershed. Cleveland's maximum population was in 1950 while Cuyahoga County and the entire Northeast Ohio region peaked in 1970. Since 1970 five counties in Northeast Ohio: Cuyahoga, Geauga, Lake, Lorain, and Medina, experienced a combined net population decline of 200,000. Cuyahoga County has lost more than 300,000 residents while Geauga, Lake, Lorain, and Medina Counties gained 100,000 residents. The population of the Chagrin River watershed communities is 305,472. Mean age ranges from 37.9 to 52.6 with a watershed mean of 44.7 years and 91% are Caucasian, 5% African American, and 3% Asian American. An average household size of 2.5 persons is found throughout the 125,040 total households. Table 5 shows the estimated watershed population from 1970 to 2000. These values are estimated as the census tract boundaries do not conform to watershed boundaries.

Table 5: Population Growth in Chagrin River Watershed 1970 to 2000

Year	Watershed Population	Population Increase Each Decade	Population Growth Rate (%)
1970	122,518	----------	--------
1980	133,244	10,726	8.05
1990	138,212	4,968	3.60
2000	165,927	27,715	16.7

1.5 Previous Planning, Protection, and Management Activities

The Chagrin River watershed has been studied since the late 1960's with the completion of the Water Quality of the Rocky and Chagrin Rivers by the Three Rivers Watershed District in August, 1970. This report, prepared by Havens and Emerson, Ltd. Engineers, presents and discusses water quality data collected on the Chagrin and Rocky Rivers from 1969 and 1970. Since the work of the Three Rivers, the Chagrin River watershed has been the subject of numerous additional studies. Important studies include those completed by OEPA (1987, 1991, 1997, 2003/2004), Cuyahoga County Health Department (1998), and ODNR (2000).

Each community has completed comprehensive plans and local zoning regulations. These plans are based on the desired and anticipated development of each community and incorporate land capability analyses. The regional planning agencies such as NEFCO and NOACA work with communities to develop updated 208 Water Quality Improvement Plans that focus on management of sewage (See Section 7.3).

The Ohio EPA NPDES Phase II Stormwater Regulations require designated communities to develop and implement stormwater management plans. Many communities in the Chagrin River watershed completed these plans and are in the process of mapping stormwater management systems, adopting local zoning regulations, and investigating illicit discharges.

2 Watershed Plan Development

To improve local land use planning and water quality throughout the Chagrin watershed and balance the development and conservation priorities of our Members, CRWP developed the *Chagrin River Watershed Action Plan* and the *Chagrin River Watershed Balanced Growth Plan* incorporating recommendations and implementation steps from the *Chagrin River Watershed TMDL* study. In 1998, the Chagrin River Watershed Partners, Inc. (CRWP) received a grant from Ohio Environmental Protection Agency (Ohio EPA) through the Section 319 to develop the Chagrin River Watershed Action Plan. This plan was submitted to Ohio EPA in May 2000. In addition to CRWP staff, trustees of member communities, local parks districts and interested citizens provided input to the Plan through four (4) public forums held during fall of 1999. These forums were held in Bainbridge and Munson Townships, City of Eastlake, and Mayfield Village. At each of these forums, CRWP presented information on the watershed and background on the concerns communities face regarding natural resource management. Participants provided feedback on their concerns and problems throughout the watershed. Agency personnel working with the professional staff provided invaluable insight into general watershed issues and tools for solving identified problems. Of particular assistance were the Lake and Geauga Soil & Water Conservation Districts, Cuyahoga County Natural Resource and Conservation Service, Ohio Environmental Protection Agency (Ohio EPA), Northeast District Office (NEDO), and the Ohio Department of Natural Resources (ODNR).

In 2003, CRWP worked with Ohio EPA and ODNR to update this Plan to receive Conditional Endorsement for the land protection and acquisition portions of the Plan. In August 2004, CRWP received additional funding from ODNR to revise the existing Chagrin River Watershed Action Plan to pursue full endorsement. These revisions were submitted in December 2005. Revisions include: input from various stakeholders, incorporation of 2003/2004 Ohio EPA sampling results, TMDL recommendations, and response to comments from Ohio EPA and ODNR and the Area Assistance Team, ands information gained through implementation of the Plan. Throughout 2006, input was received from all of the local Soil and Water Conservation Districts, local health departments, park districts, and other area non-profit organizations. This revision was endorsed in December 2006. In 2009, CRWP continued updating the Plan to include the TMDL implementation, updating goals, and incorporating the *Chagrin River Watershed Balanced Growth Plan*. In 2013 CRWP updated the plan to include detailed information and potential projects for nonattaining subwatersheds. CRWP continually revises this *Plan* to include additional water quality data, updates to the *Chagrin River Watershed Balanced Growth Plan,* the *Chagrin River Watershed Total Maximum Daily Load (TMDL)* report, subwatershed planning, and updates on projects and implementation measures. Over 100 projects and action items are noted in Table 35 of this *Plan*. Numerous projects from this list are currently underway and CRWP continues to work with our Members to obtain funding for additional projects.

The *Chagrin River Watershed Balanced Growth Plan* was endorsed by the State of Ohio on September 28, 2009. As of 2013, 28 communities have endorsed this plan. CRWP has worked with communities in the Chagrin River watershed on implementation of best local land use practices since its formation, and continues to work with the remaining Member communities on integrating and endorsing the *Plan.*

Ohio EPA completed the *Chagrin River Watershed TMDL* study in May 2007. The Chagrin TMDL identifies land development, urban runoff/storm sewers, onsite wastewater systems, municipal point sources, draining and filling of wetlands, upstream impoundments, stream bank destabilization, channelization, package plants, dredge mining, flow regulation/modification, and removal of riparian vegetation as sources of impairment. Causes of impairment include organic enrichment/dissolved oxygen, flow alterations, thermal modifications, filling, direct habitat alterations, siltation, nutrients, and loss of natural wetlands. TMDLs are established for:

- Phosphorus
- Nitrates
- Bacteria
- Habitat
- Total Suspended Solids

3 Chagrin River Watershed Partners, Inc.

The Chagrin River Watershed Partners, Inc. (CRWP) was formed by 16 cities, villages, townships, counties, and park districts in 1996 in response to increasing concerns about flooding, erosion, and water quality problems. These founders understood the need to improve land use decisions and limit the impacts of development and rising infrastructure costs due to increased stormwater quantities. In 2013, CRWP's 37 member communities represent 99% of the watershed. CRWP provides technical assistance to its members and develops cost effective solutions to minimize new, and address current, water quality and quantity problems as communities grow. CRWP's accomplishments include the on-going collaboration of local governments on watershed protection, the development of model natural resource management regulations, and the successful adoption and implementation of these models by communities. CRWP also developed a model NPDES Phase II Stormwater Management Program in use by communities across the watershed and assists members with successful implementation of the Phase II program. CRWP has developed trusted relationships with local officials and their law directors, engineers, planners, and other professional advisors. These relationships facilitate the willingness among local governments to adopt innovative zoning and stormwater practices to minimize the impacts of land use change.

CRWP supports Member services with on-going studies of watershed functions, and shares and collaborates with organizations and communities facing similar issues statewide. CRWP is funded by annual dues payments from member communities, foundation grants and grants from State and Federal agencies. Member dues are based on the amount of land in the watershed and the assessed value of the community. Working in partnership with local governments, CRWP's programs include:

- **Model code development, adoption, and implementation:** CRWP staff work with interested members to adopt and implement riparian and wetland setbacks, erosion and sediment control, conservation development, and innovative stormwater management techniques.
- **Stakeholder education:** CRWP provides presentations to councils, planning and zoning commissions, and boards of trustees, and residents on watershed management issues.
- **Landowner and developer assistance:** CRWP partners with county soil and water conservation districts to assist landowners with stream bank erosion, flooding, and other stormwater related issues.
- **Open space protection:** CRWP works with the Western Reserve Land Conservancy (WRLC), The Holden Arboretum, Gates Mills Land Conservancy, local park districts, and other conservation organizations to assist member communities in protecting open space in the watershed.
- **Stream Restoration and Stormwater Retrofit Projects:** CRWP works with Member communities on removing dams, restoring streams and incorporating stormwater retrofits throughout the watershed.

3.1 History

Although CRWP was formed in 1996, the underlying concept of the watershed approach to managing the Chagrin River goes back more than forty years. Over forty years ago, a group called the Chagrin Valley Association tried to establish a watershed coalition to address mounting concerns such as increased flooding, urbanization, water pollution, and loss of wilderness areas. Cleveland businessman John H. Byrne said in 1952, "This is why a Conservancy District (the equivalent of a watershed coalition) organization under the laws of Ohio and under local control is now a 'must'". The Chagrin Valley Association never succeeded in implementing a full watershed approach to managing the Chagrin River.

In 1986 the Chagrin River Land Conservancy (now the Western Reserve Land Conservancy (WRLC)) completed a strategic plan for their organization. The plan revealed that WRLC should encourage the creation of a separate entity to deal with the political and zoning issues in the Chagrin River watershed. Thus in 1994 a group of concerned citizens began meeting to discuss the concept of a watershed approach to manage the Chagrin River. Led by private landowners this group evolved into an impressive coalition of municipalities, land trusts, county agencies and governments, state and federal agencies, park districts, schools, and other organizations with a stake in the Chagrin river watershed. In December 1995 a group of 75 representatives from these organizations endorsed the concept of forming a watershed coalition with a steering committee and a not-for-profit corporation in the State of Ohio. From this beginning, the Chagrin River Watershed Partners Inc. was formed in 1996.

3.2 Mission Statement

The Chagrin River Watershed Partners will strive to preserve and enhance the scenic and environmental quality of the ecosystem of the Chagrin River and its watershed in a manner that assures a sustainable future for people, plants and animals.

3.3 Structure and Organization of the Board of Trustees

CRWP is organized and operated as an Ohio non-profit corporation, is qualified as a tax exempt entity under Section 501(c)(3) of the Internal Revenue Code, and is a supporting organization under Section 509(a)(3) of the Internal Revenue Code operated exclusively for the benefits of member organizations. Each member organization is entitled to elect one Regular Trustee to the Board of Trustees which, in turn, is authorized to elect At Large Trustees provided that the At Large Trustees do not exceed one half of the Regular Trustees. In 2004, the Board of Trustees developed two new classes of membership, Supporting and Sponsoring Members. These member categories are open to local nonprofit organizations, private citizens, and private companies including engineering and law firms. In 2007, the Board approved an External Services policy to allow CRWP staff to provide services to entities outside of the watershed.

Annual meetings of regular members are held once a year in May to elect trustees and officers. Regular trustees are elected annually. Vacancies in the At Large Trustees positions may be filled by a majority vote of the Regular Trustees. The Board of Trustees elects an Executive Committee that acts on behalf of the Board of Trustees between meetings. The Executive Committee is made up of the officers and either trustees or citizens.

3.4 CRWP Officers

The principal officers for CRWP are President, Treasurer, and Secretary and, if desired, a Chairperson, one or more Vice Presidents and other officers as determined by the board of trustees. Officers are elected by the Board of Trustees at the annual meeting for a one year term. The duties of each officer are as follows:

- President: Preside at meetings of the Board of Trustees and oversee the organization, supervision, management and employment of CRWP's resources and personnel.
- Vice-President: Perform the duties and powers of President in their absence.
- Treasurer: Keep custody of CRWP's funds and securities, maintain full and accurate account of all receipts, disbursements and deposits, and disburse the funds of CRWP as directed by the Board.
- Secretary: Keep minutes of all the meetings of the Board and Executive Committee.

The Board of Trustees may from time to time appoint committees. In 2004, the Board of Trustees appointed a development committee to assist CRWP in diversifying funding sources and moving beyond grant funding. The Committee included members of the board and resulted in a recommendation for supporting and sponsoring member categories that was adopted by the board.

3.5 Other Partners and Stakeholders

The Chagrin River Watershed Action Plan is a cooperative effort with input and review by various local, county and state agencies. Sections of this plan address the programs and involvement of each of these stakeholders.

- Lake County SWCD
- Geauga County SWCD
- Cuyahoga County SWCD
- Portage County SWCD
- Portage County Health Department
- Lake County General Health District
- Geauga County General Health District
- Cuyahoga County Board of Health
- Portage Parks District
- The Holden Arboretum
- Western Reserve Land Conservancy
- Gates Mills Land Conservancy
- Lake County Stormwater Management Department
- Northeast Ohio Regional Sewer District

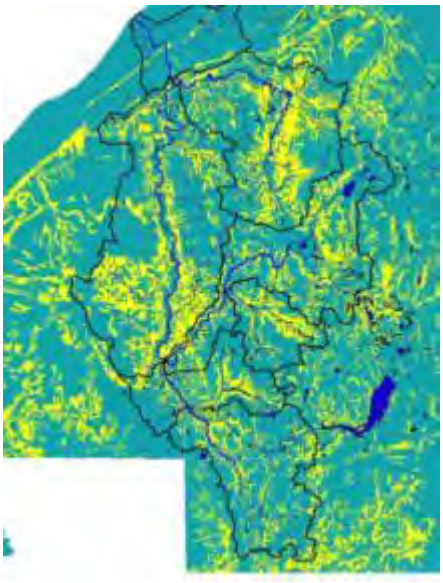
4 Geology & Soils

Glacial activity shaped the watershed with resulting soils and geologic deposits contributing to the high quality and varied habitats of the watershed. Since the last glaciers retreated approximately 12,000 years ago, the river has progressed from the upland headwater areas to create deep ravines further downstream. There are many areas on the Chagrin River and its numerous tributaries where thick glacial till has eroded, exposing sandstone and Chagrin Shale bedrock. The Chagrin River watershed lies in two distinct physiographic regions: the glaciated Allegheny Plateau and the Erie Lake plain. Soils with clayey textures in the subsoil that formed in glacial till predominate in the watershed. Somewhat poorly drained soils are common in areas with six percent slope or less.

The geology of the Chagrin River watershed creates numerous issues for watershed management and land development including: erosion, stormwater runoff, and septic suitability. Rapid runoff and erosion are significant concerns through much of the watershed because of the proximity of bedrock to the surface, the instability of the glacial deposits, and the steepness of the valley areas. With regard to septic suitability, the geologic factors that affect the operation of septic tanks include the permeability of the soil, depth to bedrock, depth to the water table, slope, and drainage. Soils in the Chagrin River watershed are generally of limited use for proper sewage disposal in many communities because of their low permeability and seasonal high water tables.

Figure 4 highlights slopes over 6%. The soils in the Lower Chagrin watershed are less clayey, but are characterized by low slopes (<4%) and are poorly drained or somewhat poorly drained.
Figure 5 illustrates the extent of the poor and moderately poor drained soils within the watershed highlighted in yellow. The terrain of most of the watershed is generally rolling with a substantial percentage of wooded land. The Chagrin River is deeply entrenched over the lower 25 miles of its length and flows on bedrock in narrow valleys through much of the watershed. The glacial deposits in the watershed overlay sandstone and shale bedrock. Bedrock is deeper than 60 inches below the soil surface in most of the watershed, but it is 20 to 40 inches below the soil surface in some nearly level or gently sloping areas. The major geologic deposits obvious in the watershed are the uppermost Sharon Conglomerate, that provides rock outcroppings and ground water input in reaches of the Upper Main and East Branches of the Chagrin River and formations of Berea Sandstone and Shale outcroppings of both Cleveland and Chagrin Shale in the lower reaches of the river.

Figure 4: Steep Slope
(Over 6% slopes are highlighted)



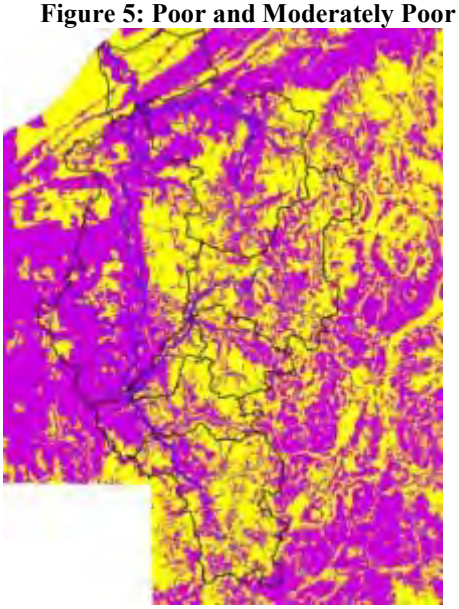


Figure 5: Poor and Moderately Poor Drained Soils

Figure 6: Steep Shale Cliffs along lower reaches of Chagrin River

5 Threatened and Endangered Species

The Chagrin River watershed is composed of a variety of plant communities; some of them rare and in need of protection. Because there are few suitable habitats remaining and most of them are under attack from invasive exotic pests, development and other sources, some of the plants in these communities are also rare. Species information for the watershed is collected by naturalists throughout the region and maintained by ODNR's Division of Natural Areas and Preserves (DNAP) on the Natural Heritage Database. Table 6 lists the species, communities, and unique features noted as the blue dots in Figure 7. Two federally endangered species, the Indiana bat (*Myotis sodalis*) and the Eastern massasauga (*Sistrurus catenatus)* are found in the watershed.

Figure 7: Threatened and Endangered Species

Table 6: Threatened and Endangered Species

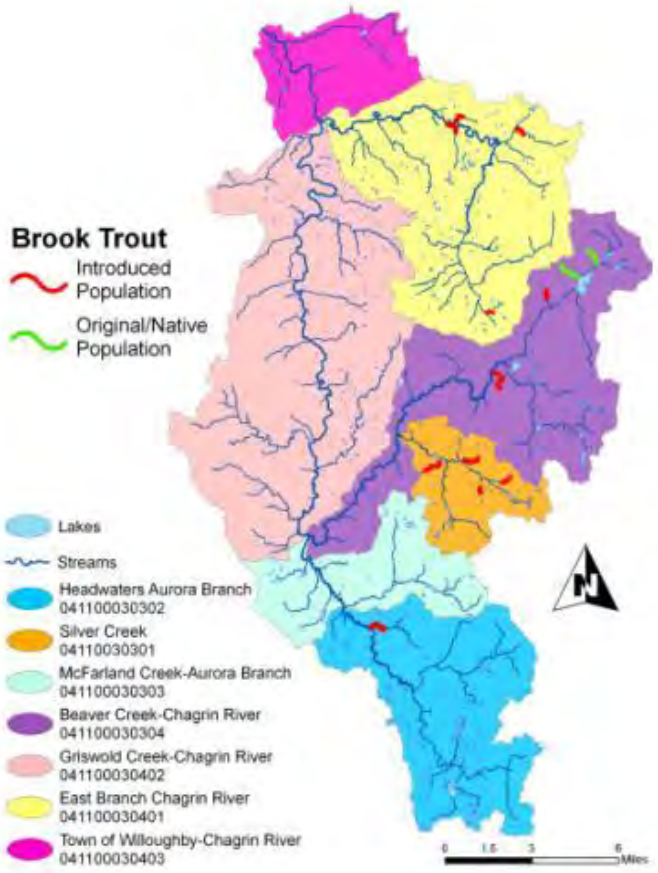
Ohio Status	Scientific Name	Common Name
E	*Cypripedium calceolus Var. parviflorum*	Small Yellow Lady's-Slipper
E	*Dendroica magnolia*	Magnolia Warbler
E	*Junco hyemalis*	Dark-Eyed Junco
E	*Juncus platyphyllus*	Flat-Leaved Rush
E	*Juniperus communis*	Ground Juniper
E	*Myotis sodalist*	Indiana Bat
E	*Najas gracillima*	Thread-Like Naiad
E	*Opsopoeodus emiliae*	Pugnose Minnow
E	*Platanthera psycodes*	Small Purple Fringed Orchid
E	*Polygonum cilinode*	Mountain Bindweed
E	*Populus balsamifera*	Balsam Poplar
E	*Sistrurus catenatus*	Eastern Massasauga
E	*Solidago puberula*	Dusty Goldenrod
E	*Sorbus decora*	Western Mountain-Ash
E	*Sphyrapicus varius*	Yellow-Bellied Sapsucker
E	*Troglodytes troglodytes*	Winter Wren
E	*Wilsonia Canadensis*	Canada Warbler
P	*Betula populifolia*	Gray Birch
P	*Cakile edentula*	Inland Sea Rocket
P	*Carex appalachica*	Appalachian Sedge
P	*Carex atlantica var. capillacea*	Howe's Sedge
P	*Carex aurea*	Golden-Fruited Sedge
P	*Castanea dentate*	American Chestnut
P	*Corallorhiza maculate*	Spotted Coral-Root
P	*Cornus rugosa*	Round-Leaved Dogwood
P	*Eriophorum viridicarinatum*	Green Cotton-Grass
P	*Euphorbia polygonifolia*	Seaside Spurge
P	*Gentianopsis crinite*	Fringed Gentian
P	*Gentianopsis procera*	Small Fringed Gentian
P	*Geum rivale*	Water Avens
P	*Hypericum majus*	Tall St. John's-Wort
P	*Juglans cinerea*	Butternut
P	*Juncus balticus*	Baltic Rush
P	*Larix laricina*	Tamarack
P	*Phegopteris connectilis*	Long Beech Fern
P	*Poa languid*	Weak Spear Grass
P	*Potamogeton natans*	Floating Pondweed
P	*Potamogeton zosteriformis*	Flat-Stemmed Pondweed
P	*Salix serissima*	Autumn Willow
P	*Shepherdia anadensis*	Canada Buffalo-Berry
P	*Sphenopholis pennsylvanica*	Swamp-Oats
P	*Spiranthes lucida*	Shining Ladies'-Tresses
P	*Utricularia minor*	Lesser Bladderwort
S	*Clemmys guttata*	Spotted Turtle
S	*Esox masquinongy*	Muskellunge
S	*Orconectes propinquus*	Great Lakes Crayfish

Ohio Status	Scientific Name	Common Name
S	*Orconectes virilis*	Northern Crayfish
S	*Porzana Carolina*	Sora
S	*Rallus limicola*	Virginia Rail
T	*Callitriche verna*	Vernal Water-Starwort
T	*Carex pallescens*	Pale Sedge
T	*Comptonia peregrine*	Sweet-Fern
T	*Cornus Canadensis*	Bunchberry
T	*Cypripedium reginae*	Showy Lady's-Slipper
T	*Elymus trachycaulus*	Bearded Wheat Grass
T	*Epilobium strictum*	Simple Willow-Herb
T	*Equisetum variegatum*	Variegated Scouring-Rush
T	*Hieracium canadense*	Canada Hawkweed
T	*Hypericum boreale*	Northern St. John's-Wort
T	*Melampyrum lineare*	Cow-Wheat
T	*Oryzopsis racemosa*	Mountain-Rice
T	*Salvelinus fontinalis*	Brook Trout
T	*Solidago squarrosa*	Leafy Goldenrod
T	*Viburnum opulus var. americanum*	Highbush-Cranberry
T	*Wolffiella gladiate*	Wolffiella
T	*Zizania aquatic*	Wild Rice
X	*Gnaphalium viscosum*	Winged Cudweed
X	*Oxalis Montana*	White Wood-Sorrel

E=Endangered; T= Threatened; S=Special Interest, X=Extirpated

The Chagrin is one of few streams in Ohio known to support the American Brook Lamprey, a nonparasitic lamprey species. Other tributaries, Spring Brook and Woodiebrook, have continually held a population of the Ohio brook trout since the last ice age. These streams provide the brook trout with a near optimal habitat and allowed ODNR to reintroduce Ohio brook trout into several other headwater streams in the Upper Main and East Branches.

Figure 8: Locations of Ohio Brook Trout Populations



5.1 Introduced, Invasive, and Nonnative Species

Invasive plants are able to persist and spread in areas not under cultivation, have a detrimental ecological effect on those ecosystems, and are difficult and expensive to remove once established. River corridors are major transport pathways for emergent and terrestrial invasive plants, due to flooding, downstream transport, and due to the wildlife corridor effects. Problems are compounded by a lack of awareness of the scope and severity of the invasive and species problem and no coordinated efforts to control invasions.

Nearer to Lake Erie a species of serious concern is the parasitic sea lamprey (*Petromyzon marinus*) that entered the Great Lakes through the ship canals and has been present in Lake Erie since 1921. It has been very damaging because part of its life cycle is spent feeding parasitically on the blood of host fish like the native lake trout. Estimates of the number of pounds of fish killed by each sea lamprey vary from about 15 to 40 pounds. The sea lamprey is an "anadromous" fish. This means that it spawns in fresh water streams, the juvenile phase is spent in the Lake, and the adult returns to freshwater streams to spawn. Prior to 2005, the sea lamprey were not a concern in the Chagrin due to the location of the Daniel's Park Dam 5 miles upstream of Lake Erie and a lack of suitable habitat sites downstream of the dam. This dam was breached in January 2005 which makes areas of the Chagrin that are suitable habitat accessible to the sea lamprey. ODNR and local fishermen continue to watch for the invasive lamprey. In 2008, the US Fish and Wildlife Service began studying options for creating a low barrier for sea lamprey near the location of the old Daniels Park dam. The U.S. Fish and Wildlife Service (FWS) completed modeling in 2009 on the historic Daniels Park Dam and the Kirtland Country Club dam on the East Branch of the Chagrin to determine if either dam acted as an effective sea lamprey barrier. FWS determined that the Daniels Park dam has not acted as a sea lamprey barrier in the past as it overtopped during 5-10 year storm events. FWS also noted that the Kirtland Country Club dam is not an effective lamprey barrier, however Ohio EPA staff still felt this was an important structure to maintain as the East Branch of the Chagrin has good habitat for the invasive lamprey.

FWS will continue sampling in the Chagrin River and East Branch to determine if sea lamprey populations are found. To date, one larval sea lamprey was captured in the Chagrin and East Branch. Factors other than the dam itself may play a part in blocking sea lampreys in the Chagrin River including temperature, water velocity, and lack of suitable larval habitat.

In addition to introduced plants and animals that are invasive and accidentally introduced, several fish species have been introduced for recreational fishing including Coho salmon, Chinook salmon, pink salmon, Atlantic salmon, brown trout, rainbow trout, rainbow smelt, and alewives. ODNR, Division of Wildlife actively stocks steelhead in the Chagrin River for recreational fishing purposes.

6 Water Resources

The Chagrin River and its tributaries are of high overall water quality due in large part to good instream and riparian habitats at most locations and significant recovery in some areas as point source discharges have been eliminated or improved. Many Chagrin River tributaries are high gradient, small streams with coldwater habitat attributes where the riparian zones are partially intact or have not been completely degraded by urban/suburban development. Significant portions of the Chagrin River are fully attaining water quality standards. The water quality in the Chagrin River is threatened by nonpoint and point source pollution associated with urbanization. These threats include nutrient enrichment; sedimentation; flow and temperature modifications from retention/detention ponds and other small impoundments; and increased stormwater volume. Development has increased nutrient enrichment by necessitating increased wastewater flows from various sources including municipal and regional wastewater treatment plants, small package wastewater treatment plants, on-site septic systems, and stormwater runoff. Growth has also increased sedimentation by increasing stormwater flows, encroaching on riparian areas, and increasing construction activity.

Concerns from state agencies and local residents and officials include the accumulation of silt and sediment from runoff and erosion; solids associated with increased loadings of nutrients, metals and organic enrichment; and elevated fecal bacteria counts that are taxing the assimilative capacity of the watershed. Ohio EPA predicts that continued attainment of designated uses will be threatened if loadings continue to increase.

The Chagrin River is not a commercial port, however, ample docking and boating opportunities exist at the mouth through access to Lake Erie. In addition there are numerous locations for canoe access including:

- Polo Field at Cleveland's South Chagrin Reservation off S.R. 87 north of Chagrin Falls, river left.
- Wilson Mills Road (Buttermilk Falls Parkway) and S.R. 174 north of Gates Mills Park, river left.
- Rogers Road Field in Cleveland's North Chagrin Reservation north of Mayfield off S.R. 174, river left.
- Old River Farm in the North Chagrin Reservation off S.R. 174 northeast of Mayfield, access river left.
- Dodd Road and Pleasant Valley Road bridge south of Willoughby Hills, roadside access river right.
- Daniels Park in Willoughby off S.R. 84, access river left.
- Todd Field in Willoughby off Glen Avenue, access river left.
- Gibson Park off Erie Road/Pelton Road north of Willoughby, access river left.
- Woodland Park in Eastlake off Woodland and Riverside Drives, access river left.
- Erie Road in Eastlake, access river left.

6.1 Climate and Precipitation

The climatic system that influences the weather in the Chagrin River watershed is known as humid continental, typified by cold and snowy winters and hot and humid summers. Average daily temperatures in the winter range from slightly below freezing in the winter months to the high 60's to low 70's during the summer months. Precipitation ranges from 40 to 47 inches per year on average. Due to the close proximity to Lake Erie, average annual snowfall in the watershed ranges from 70-100 inches. Despite the significant snowfall, 50-60% of the watershed's precipitation occurs between April and September.

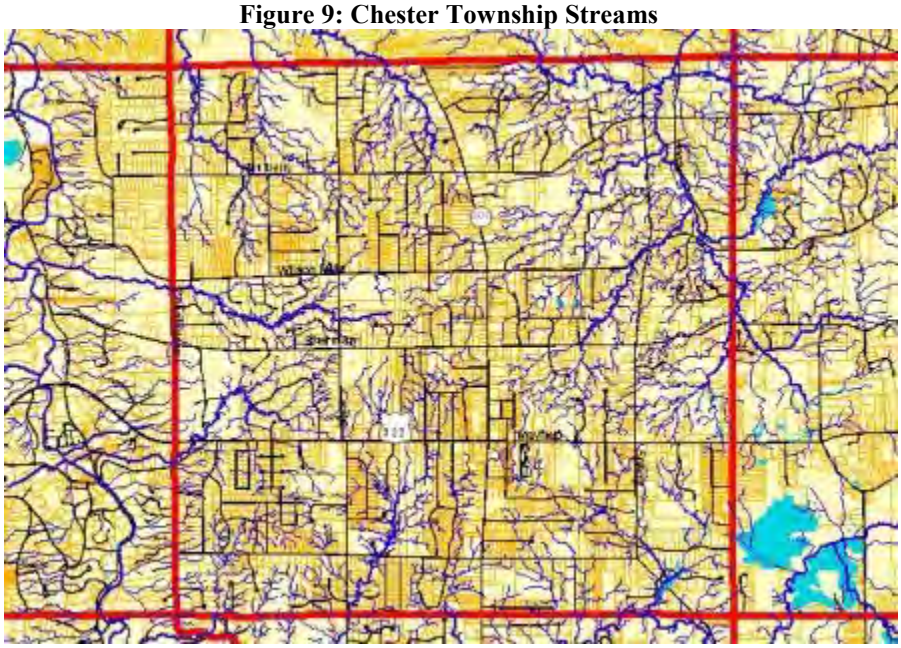
6.2 Lake Erie

The Chagrin River drains into Lake Erie in Eastlake. Lake Erie is the source of much of the drinking water in urban and suburban areas of the watershed. Lake Erie is the smallest of the Great Lakes in volume (119 cubic miles) and is exposed to the greatest effects from urbanization and agriculture. Measuring 241 miles across and 57 miles from north to south, the lake's surface is just less than 10,000 square miles, with 871 miles of shoreline. The average depth of Lake Erie is only about 62 feet (210 feet, maximum). It therefore warms rapidly in the spring and summer, and frequently freezes over in winter.

6.3 Streams

The Chagrin River and its tributaries are generally attaining water quality standards and continue to be high quality resources. Many of the headwater stream areas are vitally important in providing coldwater via springs to support downstream coldwater habitat uses. The CRWP developed geographic information systems (GIS) stream layer delineates approximately 1,700 miles of stream. Figure 9 shows the streams for Chester Township. Upon investigation of the below figure, it is easily noted that most of the mileage of stream is comprised of small headwater streams.

Figure 9: Chester Township Streams



6.4 Subwatersheds

The Chagrin River watershed is part of the hydrologic unit code (HUC) 04110003 that also includes several Lake Erie direct tributaries and the Ashtabula River. The Chagrin watershed is further divided into two 10-digit HUCs, seven 12-digit HUC watersheds, and numerous smaller subwatersheds. More detailed maps showing these watersheds can be found in Appendix B .

6.4.1 10 digit HUC Watersheds

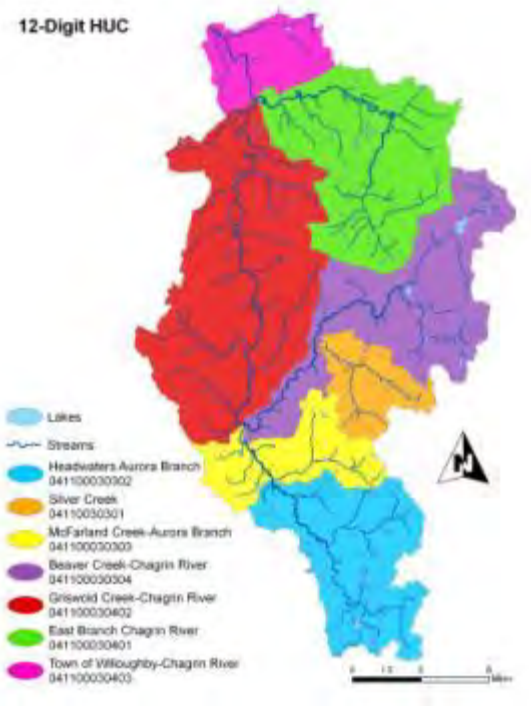
- **04110003-04: East Branch Chagrin River-Chagrin River.** Lower Portion Chagrin River from confluence of Upper Main Branch of the Chagrin River and the Aurora Branch. Also includes the East Branch.
- **04110003-03: Aurora Branch-Chagrin River.** Upper Main and Aurora Branches of the Chagrin River.

6.4.2 12 Digit HUC Watersheds

- **04110003-03-04: Upper Chagrin: Beaver Creek-Chagrin River:** Chagrin River headwaters to above Aurora Branch: Upper Main Branch Chagrin River to Aurora Branch, except Silver Creek. Includes Beaver Creek, Dewdale Creek, Springbrook, Woodiebrook, and numerous unnamed tributaries.
- **04110003-03-01: Silver Creek:** Silver Creek, includes South Branch of Silver Creek.
- **04110003-03-03: Lower Aurora Branch: McFarland Creek-Aurora Branch:** Aurora Branch above McFarland Creek to Chagrin River; includes Linton Creek and numerous unnamed tributaries.
- **04110003-03-02: Headwaters Aurora Branch:** Aurora Branch headwaters to above McFarland Creek; includes McFarland Creek and numerous unnamed tributaries.
- **04110003-04-02: Mainstem Chagrin River: Griswold Creek-Chagrin River.** Main Branch Chagrin River below Aurora Branch to above East Branch; includes Willey Creek, Pepper/Luce Creek, Griswold Creek, Caves Creek, Beecher's Brook, Upper 40/Foster's Run, Gulley Brook, and numerous unnamed tributaries.
- **04110003-04-01: East Branch Chagrin River.** East Branch Chagrin River; includes Pierson Creek, Stoney Brook, and numerous unnamed tributaries.
- **04110003-04-03: Lower Chagrin River: Town of Willoughby Chagrin River.** Chagrin River below East Branch to Lake Erie; includes Corporation Creek, Ward Creek, and numerous unnamed tributaries.

Figure 10: 10-Digit HUCs

Figure 11: 12-digit HUCs



6.5 Use Designations/Use Attainment Status

The Chagrin River Watershed is listed on Ohio EPA's 303(d) list of impaired streams and Ohio EPA completed a TMDL study in 2007. The Warmwater Habitat use defines typical warmwater assemblage of aquatic organisms. This use represents the principal restoration target for the majority of water resource management efforts in Ohio and are waters considered to be in generally good health. The Coldwater Habitat (CWH) use is intended for waters that support assemblages of coldwater organisms. Exceptional Warmwater Habitat (EWH) is a designation reserved for waters with unusual or exceptional assemblages of aquatic organisms and may include threatened or endangered species.

Ohio EPA's goal is to have 80% of streams attaining their designated aquatic life uses by 2010. From the Ohio EPA TMDL report, 64.7% of the streams in the Upper 10 Digit HUC are in full attainment, while 61.5% of streams in the lower HUC are in full attainment. In 2003-2004 Ohio EPA sampling, the Chagrin River watershed had an assessment unit score of 81. An assessment unit score of 80 is used as a benchmark above which a watershed is considered to be in good condition relative to aquatic life uses. As many streams in the Chagrin River watershed were attaining their designated uses, much of the efforts detailed in this plan are focused on protection activities to maintain the high quality of the Chagrin while also working on improvements in those impaired segments. Given the watershed's close proximity to Cleveland, CRWP considers all streams within the Chagrin River watershed to be threatened. **Error! Reference source not found.** Table 7 and Appendix B illustrate the aquatic life uses across the entire Chagrin River watershed. Note that the East Branch and all of its tributaries are designated as Coldwater Habitat (CWH).

Table 7: Aquatic life use attainment status in the Chagrin River watershed, 2003-2004

STREAM	AQUATIC LIFE USE	ATTAINMENT
04110003-04-03: Lower Chagrin River: Town of Willoughby-Chagrin River		
Chagrin River: mouth to confluence of East Branch (RM 1.5 to RM 5.0)	WWH	FULL
Corporation Creek	WWH	--
Ward Creek	WWH	NON
04110003-04-01: East Branch Chagrin River		
East Branch Chagrin River and tributaries not identified below	CWH	--
East Branch Chagrin River (RM 2.4)	CWH	NON
East Branch Chagrin River (RM 10.3-16.3)	CWH	PARTIAL
Quarry Creek (Trib. to E. Br. at RM 1.85)	CWH/EWH	FULL/FULL
Stoney Brook (Trib. to E. Br. at RM 3.57)	CWH	PARTIAL
Pierson Creek (Trib. to E. Br. at RM 6.73)	CWH/EWH	FULL/FULL
Baldwin Creek (Trib. to E. Br. at RM 7.06)	CWH	--
Trib. To E. Branch Chagrin R. at RM 10.13	CWH/EWH	FULL/FULL
Mt. Glen tributary (unnamed trib. at RM0.87)	CWH	--
Stebbins Gulch (Trib. to E. Br. at RM 10.6)	CWH	FULL
Harris Creek (Trib. to E. Br. At RM 14.62)	CWH	PARTIAL
Trib to E. Br. Chagrin R. (RM 14.80)	CWH	PARTIAL
Trib. To E. Br. Chagrin R. (RM 15.35)	CWH/EWH	PARTIAL/FULL
Trib. To E. Br. Chagrin R (RM 16.2).	CWH/EWH	FULL/FULL
04110003-04-02: Main Branch Chagrin River: Griswold Creek-Chagrin River		
Chagrin River: Daniels Park to confluence with Aurora Branch (RM 5 to 26.7)	WWH	FULL
Gully Brook (RM 11.52)	WWH	--
Caves Creek (RM 11.52	CWH	FULL
Trib. to Chagrin R. (RM 14.88)	WWH	--
Trib. to Chagrin R. (RM 15.42)	CWH	--
Pepper-Luce Creek (RM 22.81)	WWH	FULL
Unnamed Trib. to Pepper-Luce at RM 2.17	WWH	--
Willey Creek	CWH	--
Sulphur Springs Brook	CWH	--
Griswold Creek (RM 0.1)	CWH	NON
Griswold Creek (RM 4.4)	CWH	PARTIAL
04110003-03-04: Upper Main Branch Chagrin River: Beaver Creek-Chagrin River		
Chagrin River (RM 28.2 to 40)	WWH	FULL
Marsh Hawk Run (Trib. at RM 38.32)	WWH	NON

STREAM	AQUATIC LIFE USE	ATTAINMENT
Leech Tributary (Trib. at RM 41.53)	CWH	--
Dewdale Creek (RM 0.6) (Trib. at RM 42.55)	CWH	FULL
Dewdale Creek (RM 4.6) (Trib. at RM 42.55)	CWH	NON
Unnamed Trib. to Dewdale at RM 0.31	CWH	--
Unnamed Trib. to Dewdale at RM 0.31	CWH	--
Chagrin River (RM 42.6 to 45.3)	WWH	PARTIAL
Beaver Creek (RM 1.26 to mouth)	WWH	FULL
Beaver Creek (RM 2.3)	CWH	FULL
Ecklund (Trib. at RM 46.20)	CWH	--
Springbrook (Trib. at RM 47.65)	CWH	--
Woodiebrook (Trib. at RM 48.30)	CWH	--
04110003-03-01: Silver Creek		
Silver Creek at RM 5.1	CWH	FULL
Affelder Tributary (Trib. at RM 2.23)	CWH	--
South Branch Silver Creek (Trib. at RM 2.62)	WWH	FULL
Pebble Brook (Trib. at RM 3.50)	CWH	--
Hrabak Tributary (Trib. at RM 4.54)	CWH	--
Pettibone Tributary (Trib. at RM 4.58)	CWH	--
04110003-03-03: Lower Aurora Branch: McFarland Creek-Aurora Branch		
Aurora Branch Chagrin River from mouth to McFarland Creek (RM 0.3 -3.73)	WWH	FULL
McFarland Creek at RM 0.2-2.3	EWH	PARTIAL
N. Branch McFarland Creek	CWH	FULL
04110003-03-02: Headwaters Aurora Branch		
Aurora Branch at headwaters to State Route 82	WWH	NON
Aurora Branch at SR 82 to Smith Creek at RM 8.98	WWH	NON
Aurora Branch Smith Creek to McFarland Creek (RM 8.98-3.73)	CWH	FULL
Linton Creek	CWH	--
Smith Creek	CWH	FULL
Trib. To Smith Creek (Trib. at RM 2.70)	CWH	FULL
Sunny Lake Tributary (Trib. at RM 14.61)	WWH	--

6.6 Causes and Sources of Impairment from 305(b) and 303(d)

Based on aquatic life use assessment from sampling in 2003-2004, all streams draining over 50 square miles were in full attainment of their aquatic life uses. Fourteen sites were in partial attainment and 8 sites were in non-attainment. Fifty-seven percent (57%) of the coldwater habitat streams (CWH) in the lower HUC 10 subwatershed and 22% of the CWH stream segments in the upper HUC 10 subwatershed were not in full attainment of their aquatic life use. The Chagrin River is a high quality ecosystem; however it is being impacted by:

- Nutrient enrichment from failing septic systems, package plants, wastewater treatment plants, and suburban lawn care,
- Increased sedimentation due to runoff and erosion,
- Filling and drainage of wetlands for development,
- Urban runoff from stormwater, and
- Flow alterations.

Ohio EPA noted that riparian protection is an essential part of maintaining this ecosystem and general riparian encroachment needs to be minimized. CRWP and other organizations strive to protect riparian corridors

through direct land protection and zoning tools. Primary causes of impairment in the Chagrin River watershed are organic enrichment, nutrient enrichment, flow alteration, and habitat degradation.

Figure 12: Aquatic Life Use

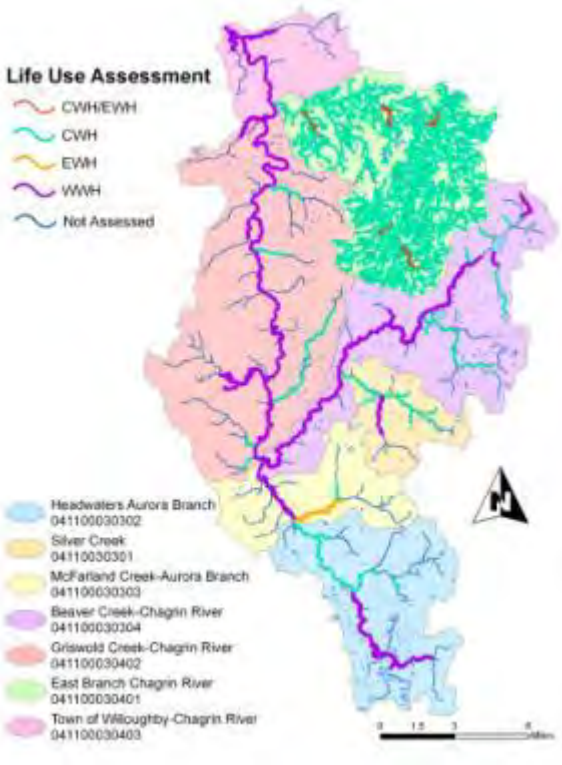
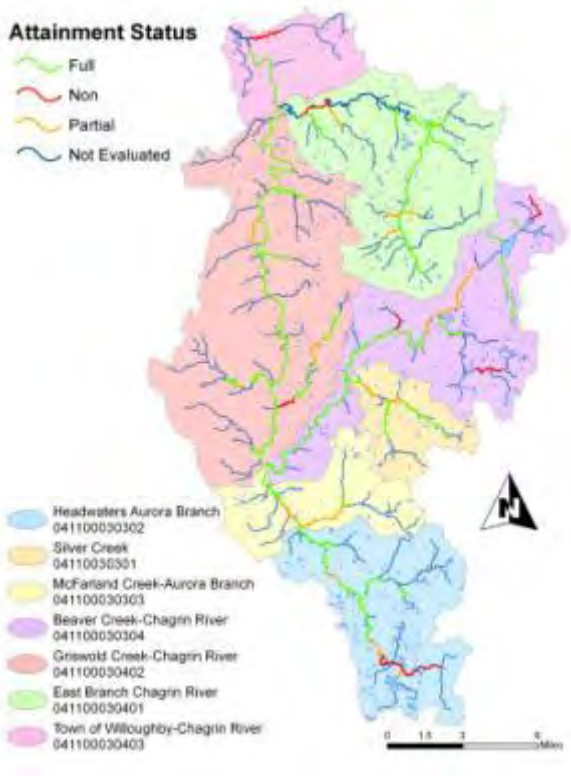


Figure 13: Attainment status of designated stream segments



6.7 Sport Fish Consumption Advisory

The Ohio Department of Health (ODH), in cooperation with Ohio EPA and the Ohio Department of Natural Resources, issues the sport fish consumption advisory for all fish caught in Ohio waters. This report provides information about whether fish consumption is safe where you fish. ODH advises that all persons limit consumption of sport fish caught from any water body in Ohio to one meal per week, due to mercury. For the Chagrin River, ODH has issued a meal advisory indicating a maximum of one meal per month of Rock Bass and Smallmouth Bass due to mercury and lead, 2 meals per week of Sunfish and Yellow Perch, and a maximum of 1 meal per month of Flathead Catfish (23" and over), Northern Pike (23" and over), and Steelhead Trout.

6.8 Stream Flow and Flooding Characteristics

Historically one of the problems in the Chagrin River watershed has been the concern of flooding and associated damage. Flooding on a large scale due to high river flows and localized flooding continue to be a major concern in the watershed. Following is a discussion of the stream flow and large scale flooding characteristics of the Chagrin River. Approximately 11.8 square miles of the Chagrin River watershed are designated as 100-year floodplain. There are 1,138 structures built in these delineated floodplains. Nearly half of these structures (524) are in the lower main branch of the Chagrin River (HUC 04110003-04-03).

The U.S. Geological Survey (USGS) maintains a water-stage recorder type gage (Station # 042090000) on the Chagrin River at Daniel's Park in the City of Willoughby. The gage is located approximately 800 feet downstream from the confluence of the East Branch and approximately five miles upstream from the River's

mouth at Lake Erie. The drainage area upstream of the gage is 246 square miles and gage datum is 594.57 feet above sea level. Prior to December 20, 1939, a nonrecording gage was located at a site 150 feet upstream at datum 7 feet higher. In 2005 the dam upstream of the gage was breached. This breach caused the gage readings at low stream flows to be undetectable. In August 2005, the gage was moved several hundred feet upstream to the side wall of the old dam on river left.

The record for annual peak flow data spans from 1913 to present with a gap from 1914 to 1925. The period of record for daily mean flow data spans from July 1925 to present with several gaps in the record. It is also important to note that water was diverted 200 feet upstream from the gage by the City of Willoughby for its municipal water supply until the water treatment plant was relocated downstream of the gage in 1988. Actual flows prior to 1988 may potentially be slightly higher or lower than the reported number due to this flow diversion.

The mean and annual peak flow data from USGS highlights several flow characteristics of the Chagrin River for the period of record:

- March has the highest mean monthly flow while August has the lowest mean monthly flow.
- The greatest maximum monthly mean flow occurred in April, 1957.
- The lowest minimum monthly mean flow occurred in August, 1930.
- The lowest instantaneous flow rate ever recorded for the period of record was 3 cubic feet per second (cfs) on July 25, 1934.

Table 8 details the highest known floods measured at the Willoughby gage. Data is ranked by peak discharge. Note the stage height varies and higher stage heights may be associated with lower flows. This inconsistency is due to the reevaluation of the rating curve for this gaging station over its life.

Table 8: Highest Known Floods at Willoughby Gage Site

Ranking	Date of Crest	Annual Peak Discharge (cfs)	Stage Height (feet)
1	22 March 1948	28,000	17.9
2	23 March 1913	24,500 (estimated)	10.3
3	26 June 1931	24,000 (estimated)	9.9
4	26 May 1989	23,900	17.1
5	19 April 1969	23,300	16.8
6	21 January 1959	22,000	9.4
7	19 January 1929	22,000	16.7
8	28 February 2011	20,000	16.57
9	28 July 2006	19,100	14.77
10	15 October 1954	18,600	15.2
11	5 March 1964	17,200	15.3
12	6 February 2008	17,400	14.0
13	5 January 2007	15,300	13.04
14	13 August 1994	15,200	14.4

Ranking	Date of Crest	Annual Peak Discharge (cfs)	Stage Height (feet)
15	27 February 1997	14,900	14.2

- The flood with the greatest discharge at Daniel's Park occurred on March 22, 1948. This is consistent with the U.S. Army Corps of Engineers determination that damaging floods on the lower Chagrin River usually occur in late winter and early Spring due to a combination of ice build-up, heavy snow melt and general moderate rainfall events across the watershed.
- In the past 20 years, the highest measured flood discharge of 23,900 cfs occurred in May 1989.
- One Eastlake resident was killed during a July 2006 flood event.

Identified impacts related to gage readings at the Daniel's Park dam include:

- **18 feet** – Major flooding occurs along the Chagrin River from Willoughby Hills to Eastlake. Considerable backwater flooding will occur along all tributaries following into the Chagrin River.
- **16 feet** – Severe flooding occurs along Trailard, Milann and Chagrin Drives and along Dodd Road in Willoughby Hills. Significant flooding possible along unprotected low lying areas in Eastlake and Willoughby.
- **13 feet** – Banks begin overflowing in Willoughby and Daniels Park. Flooding is possible along the northern section of Trailard, Milann and Chagrin drives and along Dodd Road in Willoughby Hills.
- **11 feet** – Lowland flooding occurs in Daniels Park in Willoughby and along some secondary roads near the Chagrin River.
- **8 feet** – Lowland flooding occurs in the City of Eastlake.

In reviewing Table 8, it is important to note that annual peak flow is only one factor in flood events in the Chagrin River watershed. Many floods are caused by ice build-up or localized heavy rainfalls that may not show in the annual peak flow flood records. These flooding events are a public health and safety concern for communities located in the lower portion of the watershed. The following photograph shows the ice flows and localized ice jams formed during a high flow event at the end of December 2004 just upstream of the Lakeshore Drive bridge in the City of Eastlake. It was during this flow event that the Daniel's Park Dam breached. This flow event also caused localized flooding in Eastlake.

On February 28, 2011, a high flow event caused a breach and failure of the Gates Mills Dam, as well as heavy flooding in Eastlake in multiple locations such as Boracs Landing, Willoughby Hills along Dodd Road, Daniels Park in Willoughby, Chagrin River Road, and several other secondary roads along the Chagrin River.

Figure 14: Ice Jams on Chagrin River in December 2004

In addition to flow and flood data from the Daniel's Park gage, several watershed hydrologic and flood studies have been completed for the Chagrin River. In 1997 Oxbow Engineering conducted a preliminary analysis of annual peak flow data for the Chagrin River watershed. Using log Pearson graphs, this study compared annual peak flow data from 1926 with data from 1950 and annual peak flow data from 1969 with data from 1996. While more extensive review of this data is necessary, the results of this analysis indicate an increase in annual peak flows and thus changes in the hydrologic regime of the Chagrin River and its tributaries. Prior to 1996, annual peak discharges were greater than 5000 cfs only 80 percent of the time. Based on 1996 data, these discharges are now greater than 5000 cfs 92 percent of the time. The study also found increases in annual peak flows at specific return intervals. For example, the flow associated with the 1.43 year discharge event or the flow volume with a 70 percent probability of being exceeded in a given year, increased from 6000 cfs to 7200 cfs. Looking at these findings in a different way, Oxbow found a decrease in the recurrence intervals for specific flows. For example:

- 7000 cfs was a 1.8 year event, or the discharge volume with a 58 percent probability of being exceeded in a given year. Based on 1996 data, this volume is now a 1.4 year event, or the discharge volume with a 72 percent probability of being exceeded in a given year.
- 8000 cfs changed from a 2 year event (58 percent probability) to a 1.6 year event (60 percent probability).
- 9000 cfs changed from a 2.5 year event (45 percent probability) to a 2 year event (50 percent probability).

Oxbow's findings are consistent with CRWP's examination of the annual peak discharge data showing an increase in the annual mean peak flow of approximately 1000 cfs. The impact of changes in the hydrologic regime of the Chagrin River and its tributaries seen by Oxbow and CRWP include increases in the river's bankfull event frequencies and flood stage height. Increases in the bankfull event may cause changes in channel geometry and may accelerate stream bank erosion and downstream sedimentation.

In 2001, CRWP completed a follow up study with USGS to analyze trends in annual mean stream flows and annual 7-day low flows. The analyses indicted that systematic increases in the frequency and (or) severity of flooding have not occurred with time at the Chagrin River gage. The results indicate upward trends in annual mean stream flows and annual 7-day low flows and that those trends have resulted, at least in part, from increases in precipitation since the late 1960s. Some trend results presented in the report are relatively site specific and consequently identified trends (or lack thereof) may not be equally applicable at other locations in

the basin. In addition, other factors, such as water levels in Lake Erie or the addition or replacement of culverts or bridges, can affect flood levels locally even if peak stream flow characteristics remain unchanged. The analysis also showed that the Chagrin River tended to aggrade over the period 1930-93; however, the magnitude of aggradation is sufficiently small that its effect on stages of moderate to large floods would be negligible. Stage values associated with reference stream flows of 500 and 5,000 cfs tended to remain fairly stable during the period from about 1950 to 1970 and then decreased slightly during the period from about 1970 to 1980, suggesting that the flood-carrying capacity of the stream increased somewhat during the latter period. Following a large flood in May 1989, significant changes have occurred in the relation between stage and stream flow. The most recent relation indicates that stage values associated with stream flows of 500 and 5,000 cfs are about 0.5 foot and 0.1 foot higher, respectively, than the pre-1989 levels.

6.9 Floodplains

Technical studies have also been completed to support the preparation of the Federal Emergency Management Agency's (FEMA) flood hazard maps for the communities of the Chagrin River watershed. FEMA updated the floodplain maps using digital mapping techniques, and recent topographic and other planimetric GIS layers developed by local communities. Recent map updates include:

- 2009: Lake, Geauga and Portage County maps updated through FEMA map modernization process.
- 2010: Cuyahoga County maps are in draft form and are projected to be effective November 4, 2010.
- 2011: Cuyahoga County maps effective December 3, 2010.

6.10 Wetlands

In December 2002, CRWP completed a study using GIS technology to estimate the acreage of existing and historic wetlands in the Chagrin River watershed, estimate historic wetlands losses in the watershed, and develop a ranking methodology for those wetlands that remain. Based on hydric soils, the total estimated historic wetland acreage in the Chagrin River watershed is 14,700 acres, or 8.6 percent of the watershed. Overall, the estimated wetland loss is 11,800 acres. As a result, approximately 80 percent of historic wetlands have been filled or drained in the Chagrin watershed. While this wetland loss occurred throughout the watershed, much of it is due to the draining and filling of coastal wetlands in Lake County along the Lake Erie shore.

CRWP's study also evaluated the remaining wetlands to determine that are threatened by human activity, well protected, or potentially high quality but not well protected. The methodology was based on the premise that proximity to human activity, as indicated by buildings or pavement, indicates threats to wetlands. The methodology also assumed that proximity to endangered species, floodplains, or protected areas indicates high quality wetlands. A GIS program was written to rank each wetland remaining in the watershed based on these assumptions. This analysis showed that approximately 1,075 acres of wetland in the watershed may be high quality, but are not protected. To minimize increases in flooding, erosion, water quality problems, and habitat fragmentation and loss as communities grow, it is imperative to maintain the water quality and habitat functions of these wetland ecosystems through land protection and development controls.

6.11 Lakes and Reservoirs

Numerous natural, enhanced and manmade lakes exist in the watershed, including Bass Lake, Lake Lucerne, Lake Louise, Sunny Lake, Kiwanis Lake, Paw Paw Lake, Beartown Lakes, Lake Taylor, Briar Hill Lake, Tanglewood Lake, Deer Lake, and Best Lake. Many of these lakes have been created or enhanced through dam construction, are primarily for recreational purposes, and are privately owned by either home owners surrounding the lake or by the homeowners association. Many of the lakes and their associated dams are not regularly inspected and maintained and may not have emergency management plans in place. More information on lakes and their associated dams can be found in Sections 10.15 and 11.

6.12 Ground Water

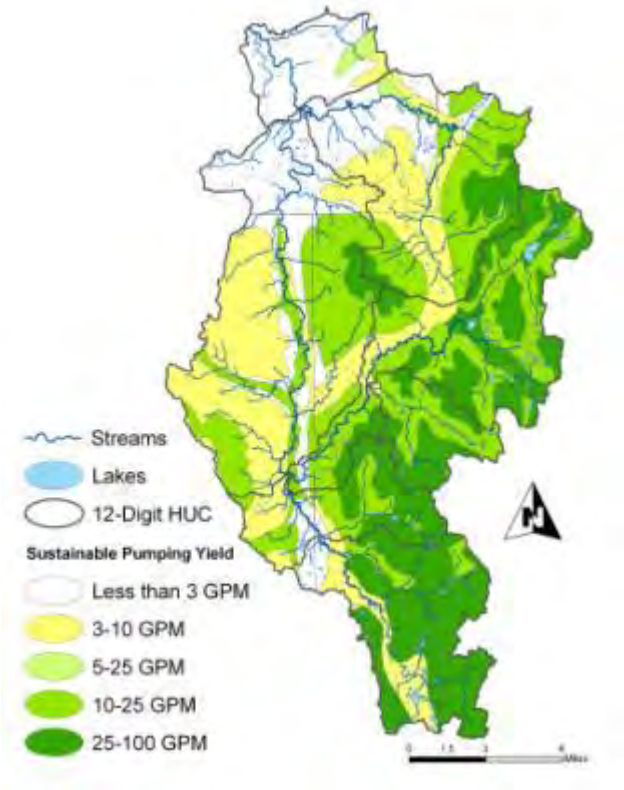
The ground water supply for the Chagrin watershed is mainly from deeply buried remnant river valleys. These areas are the ancestors of the Grand, Chagrin and Cuyahoga Rivers and are locations of sand and gravel

aquifers. Many of the residents in the watershed rely on private ground water wells for their drinking water supply. In addition, several public water supplies, such as the City of Chardon, Village of Chagrin Falls, and Tanglewood Lake in Bainbridge Township, provide ground water supply to communities.

Ground water supplies are available from localized unconsolidated glacial deposits and from bedrock units. Larger supplies are found in areas underlain by Sharon Conglomerate or in sand and gravel deposits. The ground water resource maps detail estimates of sustainable pumping yield available from the aquifers. The ground water resource maps are provided by ODNR, Division of Soil and Water. In Lake County, most of the ground water resources are limited with pumping rates ranging from 0-25 gallons per minute (GPM). Most of the area produces less than 3 GPM due to heavy clay deposits overlying shale bedrock. The most productive areas will produce 25-100 GPM and are located on the upper reaches of the watershed, mainly in the Upper Main and Aurora Branches as shown in

Figure 15 below.

Figure 15: Ground Water Resources



6.12.1 Ground Water Pollution Potential

The DRASTIC mapping system was chosen by ODNR to allow the pollution potential of an aquifer to be evaluated systematically using existing information. The DRASTIC system consists of two major elements:

1. Designation of mappable units, termed hydrogeologic settings, and
2. Superposition of a relative rating system to determine the pollution potential.

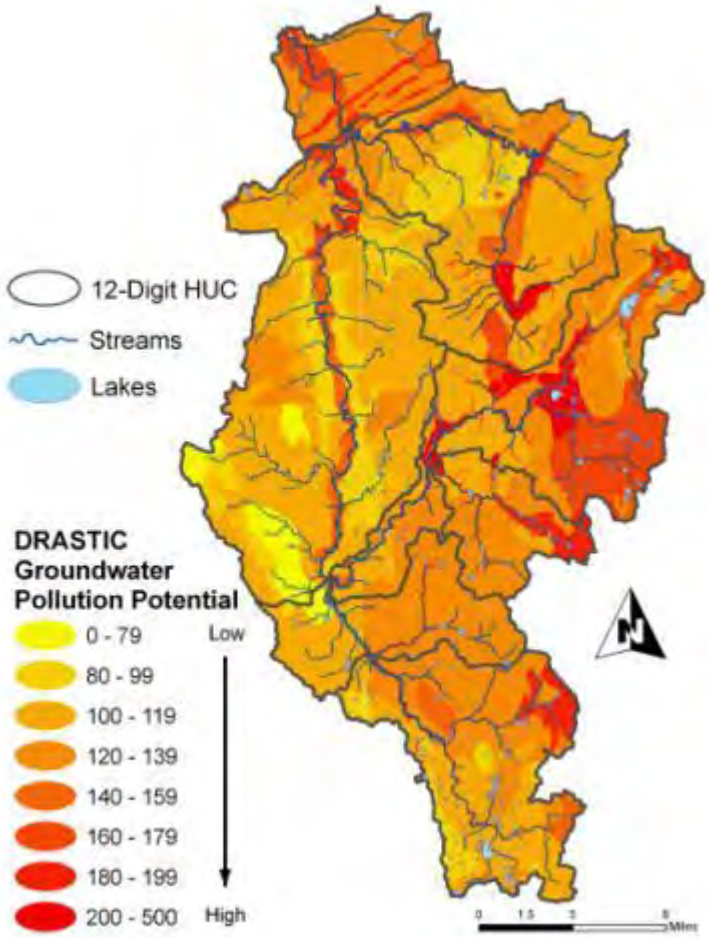
Hydrogeologic settings represent mappable units with common hydrogeologic characteristics and, as a consequence, common vulnerability to contamination. Hydrogeologic settings form the basis of the system and incorporate the seven major hydrogeologic factors that affect and control ground water movement and occurrence, that are:

Depth to Water
Recharge **(**Net **R**echarge)
Aquifer Media
Soil Media
Topography (% slope)
Impact of the Vadose Zone Media
Conductivity (Hydraulic) of the Aquifer)

DRASTIC uses a numerical rating and weighting system that is combined with the seven DRASTIC factors listed above to calculate a ground water pollution potential index or relative measure of vulnerability to contamination. The higher DRASTIC index number correlates to a greater vulnerability to contamination**.**

Figure 16 shows the relative ground water pollution potential in the Chagrin River watershed. The areas of highest ground water pollution potential in the Chagrin River watershed are focused along stream corridors, remnant beach ridges in Lake County, and in the headwater reaches of the Upper Main Branch of the Chagrin in Newbury, Munson and Russell Townships in Geauga County. Several of these areas include gravel mining operations, coldwater streams, and extensive wetlands.

Figure 16: Ground Water Pollution Potential



7 Land Use

Water quality and quantity in the Chagrin River watershed is a direct result of changing land use. The type of land use, together with soil, climate, and topography, determines the amount and quality of stormwater runoff. Typical pollutants for land uses in the Chagrin River watershed include riparian encroachment, wetland and floodplain loss, hydromodification, failing home sewage treatment systems, fertilizers and pesticides from lawn care, sediments from stream banks and construction activities, and oils and salts from roads. Historically, much of the land use within Chagrin watershed was agricultural, with nurseries in Lake County, dairy farms and associated crops in Portage and Geauga Counties. Numerous mills also existed along the Chagrin River to power equipment or to process grain.

7.1 Existing Land Use and Impervious Cover

The primary land use in the Chagrin River watershed is low density residential. Approximately 14% of the Chagrin River watershed communities are either zoned as open space or are protected by a park district or conservation easement. Based on an impervious cover study completed in 2004, approximately 50% of the Chagrin watershed communities were undeveloped or are underdeveloped. Of the remaining 36% of the watershed that has been developed, the majority of this has been developed as residential with low density residential of more than two acres per home representing about half of the developed area of the watershed. The existing land use planning and zoning is also heavily focused on low density residential uses. Under existing zoning, the watershed at build out would be comprised of 78% residential, of which 46% is low

density residential, 8% commercial/retail/industrial and 14% open space including properties currently protected by a park district or conservation easement. Additional details are presented in Section 7.2.

The 1994 LANDSAT data estimated impervious cover at approximately 13% in the watershed. The highest amounts of impervious cover are in the Lower Chagrin River while the least was found in the East Branch.

Table 9: 1994 LandSat Analysis of Land Cover in Chagrin River Watershed

Land Cover	Area (acres)	% of Watershed
Water	7,374	4
Wetland	6,116	4
Urban Open Land	30,686	18
Shrub/Brush	5,859	3
Forest Cover	78,643	46
Conifers	11,439	7
Urban Development	13,005	8
Roads	14966	9
Other	1242	1
Total Watershed	**169,330 (265 sq. mi.)**	**100**

In interpreting these results, it is important to note that these percentages are of land cover based on remote sensing data with a 30 meter resolution and not of land use. For example, the 18% for Urban Open Land counts any non-forested ground including golf courses, agricultural uses and parking lots. Forest cover represents 46% of the watershed but may this also include home lots and parks. It would be incorrect to conclude from these percentages that 18% of the watershed is pervious open land or that 46% is under continuous forest cover. This data provides a rough estimation of land cover and should only be used as an initial approximation. Considering the concerns of using the LandSat data and the inability to complete build-out analyses based on these previous studies, CRWP completed an additional impervious cover study in 2004.

7.2 CRWP Impervious Cover Study

In 2004 CRWP completed an impervious cover analysis of the Chagrin River watershed to:

- Estimate increases in impervious cover from land use changes due to development, and
- Qualitatively assess the effectiveness of BMPs to control imperviousness or to control the resulting impacts of increased impervious cover.

By understanding the impact of potential land use changes on the flooding, erosion, and water quality problems of the watershed, this project will assist CRWP Member communities in making informed land use planning and management decisions. For this study, community zoning codes were grouped into a common set of land use categories (e.g., residential less than ½-acre, nonresidential, and non-developable). An estimate of the impervious cover was made for each land use category within the Chagrin River communities using available impervious cover estimates and limited measurements from available digital aerial photographs.

Table 10: Land Use in Chagrin River Watershed Communities

Community	Land Use Category Percentages						
	Residential				Non-Residential		Non-Developable
Name	<1/2 acre	1/2 - 1 acre	1 - 2 acres	>2 acres	High	Medium	Protected Open Space
Auburn Township	0.0%	1.1%	34.1%	38.6%	2.0%	3.3%	20.9%
City of Aurora	11.3%	29.2%	19.4%	18.1%	1.6%	8.6%	11.8%
Bainbridge Township	0.0%	0.0%	0.0%	84.7%	1.2%	3.9%	10.1%
City of Beachwood	4.0%	64.9%	0.0%	0.0%	7.4%	22.3%	1.4%
Village of Bentleyville	0.0%	0.0%	60.6%	0.0%	0.0%	0.0%	39.4%
Chagrin Falls Township	0.0%	0.0%	0.0%	78.7%	0.0%	0.0%	21.3%
Village of Chagrin Falls	26.6%	44.3%	1.5%	0.0%	1.9%	9.2%	16.5%
City of Chardon	3.1%	12.1%	10.9%	28.9%	4.6%	20.2%	20.1%
Chardon Township	0.0%	0.0%	45.1%	33.5%	0.9%	0.0%	20.5%
Chester Township	0.0%	0.0%	24.6%	70.1%	1.5%	0.9%	3.0%
City of Eastlake	26.2%	20.7%	0.0%	10.3%	9.3%	21.5%	12%
Gates Mills Village	0.4%	0.0%	1.8%	79.7%	0.1%	0.0%	17.9%
City of Highland Heights	0.0%	77.8%	0.0%	0.0%	1.5%	20.7%	0.0%
Hunting Valley Village	0.0%	0.0%	0.0%	76.1%	0.0%	0.0%	23.9%
City of Kirtland	1.4%	24.2%	28.5%	15.4%	1.0%	4.8%	24.6%
Kirtland Hills Village	0.0%	0.0%	0.0%	79.7%	0.2%	0.0%	20.1%
City of Lyndhurst	3.2%	86.1%	0.0%	0.0%	2.5%	1.0%	7.3%
City of Mayfield Heights	58.8%	12.8%	0.0%	0.0%	8.9%	12.7%	6.8%
Mayfield Village	54.4%	0.0%	0.0%	0.0%	0.9%	16.6%	28.0%
City of Mentor	2.6%	26.4%	16.2%	0.6%	10.4%	26.3%	17.6%
Moreland Hills Village	0.1%	0.0%	0.0%	87.3%	0.2%	0.0%	12.4%
Munson Township	0.0%	0.0%	0.0%	76.3%	1.8%	8.3%	13.5%
Newbury Township	0.0%	0.0%	0.0%	82.1%	2.2%	3.7%	12.0%
Orange Village	7.6%	13.7%	76.5%	0.0%	1.5%	0.2%	0.6%
City of Pepper Pike	0.9%	79.4%	0.0%	0.0%	0.5%	18.6%	0.6%
Russell Township	0.0%	0.0%	0.0%	85.4%	0.2%	0.1%	14.3%
City of Solon	6.7%	60.1%	0.0%	9.1%	1.9%	17.8%	4.3%
South Russell Village	18.5%	52.5%	11.8%	9.7%	1.0%	1.3%	5.2%
Waite Hill Village	0.0%	0.0%	0.0%	84.4%	0.0%	0.0%	15.6%
City of Wickliffe	9.4%	47.1%	0.0%	0.0%	0.0%	33.4%	10.1%
City of Willoughby	27.2%	8.2%	0.0%	31.0%	6.5%	22.2%	5%
City of Willoughby Hills	0.3%	81.4%	0.0%	0.0%	1.2%	2.5%	14.7%
Woodmere Village	0.0%	100.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Total/Avg. Study Area	**4%**	**17%**	**12%**	**46%**	**2%**	**6%**	**14%**

CRWP evaluated the current level of land development to establish future development scenarios. The development status of a given parcel of land can range from vacant/totally undeveloped to built-out/fully developed within its current zoning. For the purposes of this study, three status levels have been defined:

- **Developed:** Parcels of land that are considered fully developed within their underlying zoning category. Future development of these parcels is not anticipated.
- **Developable:** Parcels of land that are considered potentially developable within their underlying zoning category. The build-out land use scenario assumes that all developable land will ultimately be developed at its current zoning.
- **Non-Developable:** Areas that are zoned as open space or designated as "protected" lands, including conservation easements, parks and vacant municipal property.

For residential areas, parcel size compared to zoning determined if a property was developed. For non-residential areas, developable parcels were identified by a low ratio of building area to parcel size.

As seen in Table 11, 50 percent of the study area is developable, indicating that the land use decisions yet to be made within these communities will significantly affect watershed imperviousness. Over one third (37%) of the study area is developed, and the remainder (13%) is considered non-developable and is protected by parks, conservation easements, or parkland zoning.

Table 11: Developable, Developed and Non-Developable Percentages by Community

Community		Land Use Zoning Percentages		
Name	Area (ac)	Developable	Developed	Non-Developable
Auburn Township	19,202	57.3%	21.8%	20.9%
City of Aurora	15,439	65.4%	22.8%	11.8%
Bainbridge Township	16,533	42.5%	47.4%	10.1%
City of Beachwood	3,364	47.4%	51.2%	1.4%
Village of Bentleyville	1,675	39.8%	20.8%	39.4%
Chagrin Falls Township	330	37.2%	41.5%	21.3%
Village of Chagrin Falls	1,349	31.2%	52.3%	16.5%
City of Chardon	2,951	43.1%	36.8%	20.1%
Chardon Township	14,640	56.7%	22.7%	20.5%
Chester Township	15,033	47.0%	50.0%	3.0%
City of Eastlake	1,548	50.0%	38.1%	12.0%
Gates Mills Village	5,822	36.5%	45.6%	17.9%
City of Highland Heights	3,284	48.9%	51.1%	0.0%
Hunting Valley Village	5,108	55.0%	21.0%	23.9%
City of Kirtland	10,693	52.1%	23.3%	24.6%
Kirtland Hills Village	3,620	51.8%	28.1%	20.1%
City of Lyndhurst	2,810	30.0%	62.8%	7.3%
City of Mayfield Heights	2,699	31.4%	61.8%	6.8%
Mayfield Village	2,514	39.4%	32.7%	28.0%
City of Mentor	4,998	31.0%	51.4%	17.6%
Moreland Hills Village	4,641	23.0%	64.6%	12.4%
Munson Township	16,196	42.4%	44.1%	13.5%
Newbury Township	18,280	64.6%	23.4%	12.0%
Orange Village	2,432	47.7%	51.7%	0.6%
City of Pepper Pike	4,567	47.5%	51.9%	0.6%
Russell Township	12,327	35.5%	50.1%	14.3%
City of Solon	13,088	55.2%	40.5%	4.3%
South Russell Village	2,486	40.0%	54.9%	5.2%
Waite Hill Village	2,734	58.9%	25.5%	15.6%
City of Wickliffe	541	37.5%	52.4%	10.1%
City of Willoughby	3,974	55.2%	39.8%	5.0%
City of Willoughby Hills	6,944	54.6%	30.7%	14.7%
Woodmere Village	211	14.2%	85.8%	0.0%
Total/Avg. Study Area	**346.9**	**50%**	**37%**	**13%**

Table 12 indicates an average imperviousness of 8.4% in watershed communities. Further analysis completed by Bainbridge Township indicates that these numbers may be too low in some areas. The Bainbridge Township analysis results in a higher amount of impervious cover because it was based on the township's actual built conditions that have more impervious cover than the underlying zoning would have allowed due to historic uses, variances, and legal challenges to the township's zoning that have resulted in higher density development. CRWP's analysis is simply based on underlying zoning.

The value of 8.4% impervious cover (although it may underestimate the actual amount of impervious cover) is characteristic of a rural/suburban watershed, based on numerous watershed studies. The average imperviousness is less than 5 percent for the highly underdeveloped communities including Bentleyville, Chardon Township, Hunting Valley, Kirtland Hills, Newbury, and Waite Hill. Many of these communities have large estates and open tracts that could be further subdivided if not protected.

Table 12: Existing Impervious Cover - 2005

Community Name	Average
Auburn Township	5.0%
City of Aurora	8.3%
Bainbridge Township	6.2%
City of Beachwood	16.1%
Village of Bentleyville	4.5%
Chagrin Falls Township	5.2%
Village of Chagrin Falls	18.3%
City of Chardon	12.4%
Chardon Township	4.8%
Chester Township	7.6%
City of Eastlake	15.3%
Gates Mills Village	5.7%
City of Highland Heights	14.3%
Hunting Valley Village	3.9%
City of Kirtland	6.8%
Kirtland Hills Village	4.3%
City of Lyndhurst	15.6%
City of Mayfield Heights	25.5%
Mayfield Village	15.2%
City of Mentor	18.8%
Moreland Hills Village	6.8%
Munson Township	8.6%
Newbury Township	4.5%
Orange Village	9.8%
City of Pepper Pike	13.0%
Russell Township	5.8%
City of Solon	13.4%
South Russell Village	12.8%
Waite Hill Village	4.2%
City of Wickliffe	15.2%
City of Willoughby	16.0%
City of Willoughby Hills	8.7%
Woodmere Village	19.3%
Total/Avg. Study Area	**8.4%**

Studies have identified a correlation between imperviousness and stream quality. The following excerpt is taken from the Watershed Vulnerability Analysis report (page 4, Center for Watershed Protection, 2002):

The research generally indicates that certain zones of stream quality exist, most notably at about 10% impervious cover, where the most sensitive stream elements are lost from the system. A second threshold appears to exist at around 25 to 30% impervious cover, where most indicators of stream quality consistently shift to a poor condition (e.g., diminished aquatic diversity, water quality, and habitat scores).

The communities that exceed the first threshold of stream vulnerability (i.e., greater than 10% impervious cover) include:

- Beachwood
- Chagrin Falls Village
- Chardon
- Eastlake
- Highland Heights
- Lyndhurst
- Mayfield Heights
- Mayfield Village
- Mentor
- Pepper Pike
- Solon
- South Russell
- Wickliffe
- Willoughby
- Woodmere

The City of Mayfield Heights exceeds the second threshold of stream vulnerability (i.e., greater than 25% impervious cover).

The CRWP Headwater Stream study showed that high quality headwater stream biology is only found in watersheds with less than 6% impervious cover (EnviroScience Inc., 2003). The communities that are less than this 6% impervious cover threshold include:

- Auburn
- Bentleyville
- Chagrin Falls Township
- Chardon Township
- Gates Mills
- Hunting Valley
- Kirtland Hills
- Newbury
- Russell
- Waite Hill

The second scenario of the impervious cover study evaluated the 100% build-out of developable land according to the underlying zoning. Table 13 details the average amount of impervious cover at complete build-out to underlying zoning and the change from the existing amount of impervious cover. As a result the average imperviousness of 16.3% for Chagrin River watershed communities under build-out conditions.

Table 13: Average Impervious Cover at Build-Out

Community Name	Average Value	Change
Auburn Township	11.8%	6.8%
City of Aurora	21.2%	12.9%
Bainbridge Township	11.1%	4.9%
City of Beachwood	34.2%	18.1%
Village of Bentleyville	8.4%	3.9%
Chagrin Falls Township	7.7%	2.4%
Village of Chagrin Falls	27.3%	8.9%
City of Chardon	23.5%	11.1%
Chardon Township	9.7%	4.8%
Chester Township	11.0%	3.3%

Community Name	Average Value	Change
City of Eastlake	35.0%	19.6%
Gates Mills Village	8.1%	2.5%
City of Highland Heights	30.4%	16.1%
Hunting Valley Village	7.5%	3.6%
City of Kirtland	14.9%	8.1%
Kirtland Hills Village	7.9%	3.5%
City of Lyndhurst	22.7%	7.1%
City of Mayfield Heights	39.1%	13.6%
Mayfield Village	31.9%	16.7%
City of Mentor	32.0%	13.3%
Moreland Hills Village	8.4%	1.7%
Munson Township	13.4%	4.9%
Newbury Township	11.5%	7.0%
Orange Village	16.4%	6.7%
City of Pepper Pike	29.2%	16.2%
Russell Township	8.3%	2.5%
City of Solon	28.6%	15.1%
South Russell Village	22.6%	9.7%
Waite Hill Village	8.0%	3.9%
City of Wickliffe	33.9%	18.7%
City of Willoughby	32.7%	16.7%
City of Willoughby Hills	20.7%	12.0%
Woodmere Village	22.0%	2.8%
Total/Avg. Study Area	**16.3%**	**7.9%**

This study highlighted that the Chagrin River watershed is near a critical point of development and future development must be appropriately planned and include good stormwater management. Steps local communities can complete to ensure development continues to occur in a sustainable manner include:

- Comprehensive planning,
- Targeted open space acquisition,
- Riparian and wetland setbacks,
- Comprehensive stormwater management including low impact development and green infrastructure,
- Conservation development.

In addition to investigating the total amount of developed area and impervious cover throughout the Chagrin River watershed, this study investigated the impact of impervious areas, investigated the alternative development practices, and finally quantifies the effectiveness of various stormwater management practices.

7.3 Current Land Use Plans and Predicted Trends

In addition to numerous watershed scale studies and plans that have been completed, each of the communities in the Chagrin River watershed have completed comprehensive planning activities and have enacted local zoning regulations. On a regional scale 208 water quality management plans have also been created.

7.3.1 208 Water Quality Management Plans

Section 208 of the Clean Water Act requires states to identify regional water quality planning areas for the preparation, maintenance and implementation of water quality management plans. These Section 208 plans contain information used to address both municipal wastewater treatment issues and nonpoint source pollution management and control. Information from all Section 208 plans is combined to form the State Water Quality Management (WQM) plan. To facilitate the creation of the state WQM, the Governor of Ohio identified six

urban areas of Ohio for regional water pollution control planning. Areawide Councils of Governments were then designated as the lead planning agencies for developing what became known as 208 plans. The six regional water quality planning areas cover 25 counties. The designated planning organizations that are authorized to develop Section 208 plans for the areas of the Chagrin River watershed are:

- **NEFCO** - Northeast Ohio Four County Regional Planning and Development Organization that covers the greater Akron metropolitan area, including Portage County;
- **NOACA** - Northeast Ohio Areawide Coordinating Agency that covers the greater Cleveland metropolitan area, including Cuyahoga, Lake, and Geauga Counties;

Each Areawide Planning Agency maintains its own 208 plan to address local water quality needs and problems. Ohio EPA oversight helps determine water quality priorities and consistency with other plan requirements and programs. The initial 208 plans and subsequent updates or amendments are included as part of the State Water Quality Management (WQM) Plan required under Section 303 of the CWA.

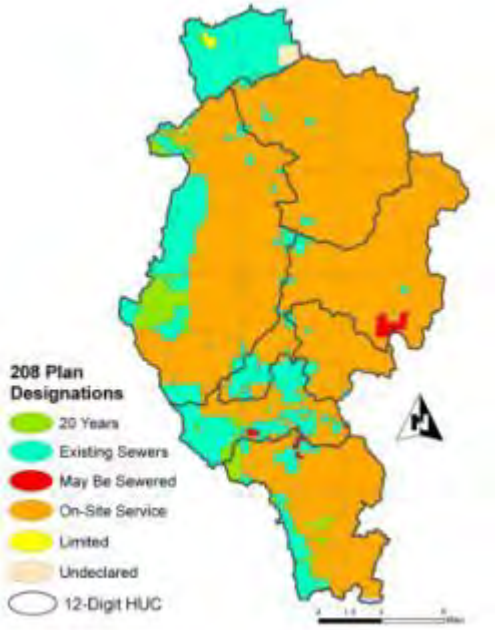
The plans developed by NEFCO and NOACA generally designate areas as one of the below:

- **Sewered:** Area is currently served with sanitary sewers: Area is totally served with sanitary sewers connected to a specified, existing publicly owned treatment facility; all new construction will be connected to the central sewer system.
- **20 Years:** Area is expected to be served with sanitary sewers within the next 20 years
- **On-Site:** Area designated to remain on on-site systems for the foreseeable future.
- **Limited:** Limited Sewering likely within the next 20 years.
- **Undeclared:** Areas for which no wastewater management options have been declared.

As noted in

Figure **17**, 76% of the Chagrin River watershed is planned to manage sewage with onsite wastewater management. Approximately 20% of the Chagrin is already sewered. The sewered areas and those areas that are planned to be sewered in the next 20 years are concentrated in Lake and Cuyahoga Counties.

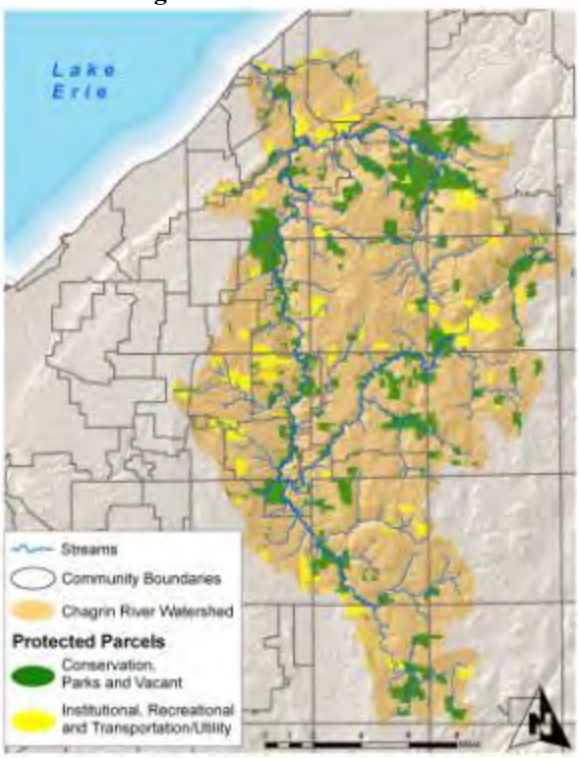
Figure 17: 208 Designations



7.4 Protected Lands

Approximately 14% of the Chagrin River watershed is protected through land ownership by park district, conservation easements by local land trusts, or zoned open space, shown in Figure 18. CRWP works with the below entities that protect, manage, and maintain these lands, complete restoration projects, and provide a wide array of recreational and educational activities. In addition to these groups, property is maintained as open space by communities, local park commissions, home owners associations, smaller land trusts, and private camps and parks.

Figure 18: Protected Lands



7.4.1 Audubon Society of Greater Cleveland/Ohio Department of Natural Resources

The Audubon Society of Greater Cleveland has four nature preserves in the watershed, including the 149 acre Blanche Catherine Novak Sanctuary, the 165 acre Aurora Sanctuary, the 113-acre Michael and Lenore Molnar Sanctuary, and the 81 acre Hach-Otis Preserve. The Novak, Aurora, and Hach-Otis properties are also designated as State Nature Preserves by Division of Natural Area and Preserves of ODNR. The Audubon Society engages in preservation and maintenance of these areas as valuable bird and ecosystem habitat.

7.4.2 Cleveland Metroparks

The Cleveland Metroparks has two large parks that provide recreational opportunities including hiking, biking, and fishing to watershed residents. The South Chagrin Reservation in the Upper Main Branch in Cuyahoga County and North Chagrin Reservation along the Main Branch watershed in Cuyahoga and Lake Counties.

7.4.3 Cleveland Museum of Natural History

The Cleveland Museum of Natural History (CMNH) manages approximately 100 acres in the Chagrin River watershed with extremely unique features and biological communities. CMNH carefully manages properties to discourage invasive plant species and maintain biodiversity.

7.4.4 County Soil and Water Conservation Districts

Each of the four County Soil and Water Conservation Districts (SWCDs) can hold conservation easements in the watershed. In addition to conservation easements, the SWCDs manage USDA Programs such as the Conservation Reserve Program, Conservation Reserve Enhancement Program, Wetlands Reserve Program, and the Farmland Protection Program.

7.4.5 Gates Mills Land Conservancy

The Gates Mills Land Conservancy is funded through the proceeds from a tax levy for the conservation, protection and preservation of land, water, forests or wetland areas in their natural scenic, open or wooded condition or as suitable habitat for fish, plants or wildlife, that includes the acquisition of property or interests therein deemed necessary to carry out these purposes. The Conservancy now has over 400 acres of land either purchased or in easements in the Village of Gates Mills.

7.4.6 Geauga Park District

The Geauga Park District has numerous protected properties in the Upper Main Branch, Aurora Branch, Griswold Creek, and East Branch subwatersheds protecting approximately 2,700 acres. These include the West Woods Park, Walter C. Best Wildlife Preserve, Rookery, Becvar Preserve, Mayer Preserve, Bass Lake Preserve, Beaver Creek Preserve, Beartown Lakes, Spring Brook, Bessie Benner Metzenbaum, Sunnybrook Preserve, Hehmeyer Preserve, Ellerin Preserve, Orchard Hills, and Frohring Meadows. Geauga Park District routinely performs monitoring for invasive plant species, inventory of plant and animal species, and educational programs.

7.4.7 Holden Arboretum

The Holden Arboretum is a private organization and includes the actively managed Arboretum collections used by horticulture professionals from around the world, and many horse, hiking, and skiing trails available for member use. Holden owns approximately 3,400 acres and holds conservation easements on an additional 1,240 acres in Lake and Geauga Counties in the East Branch watershed. In addition to conserving and managing thousands of acres and providing cultural and horticultural interest through Holden's maintained horticultural collections, Holden offers a variety of services to watershed residents including an annual plant sale, numerous educational activities and guided hikes throughout the year.

7.4.8 Lake Metroparks

Lake Metroparks currently manages eight distinct park properties in the Chagrin River watershed. These parcels total 1,600 acres of land ranging from riparian corridors at Chagrin River Park, Gulley Brook and Ward Creek to upland forests at Chapin Forest Reservation, Penitentiary Glen Reservation, and Lake Farmpark. Lake Metroparks will continue to focus natural area protection on the main stem and East Branch of the Chagrin and its major tributaries such as Gulley Brook and Ward Creek in Lake County.

7.4.9 Portage Park District

The Portage Park District recently completed a park plan and currently manages 95 acres known as the Chagrin Headwaters Park in the Chagrin River watershed.

7.4.10 Western Reserve Land Conservancy

The Western Reserve Land Conservancy was formed in 2006 as a merger between several land trusts in Northern Ohio. The Chagrin River Land Conservancy (CRLC) was the organizing land trust that worked to complete this merger. CRLC was formed in 1986 to support land preservation in the Chagrin River watershed through direct land protection. WRLC is a 501(c)(3) not for profit land conservation organization that will continue the efforts of CRLC in the Chagrin watershed and throughout the Western Reserve. WRLC has been effective in land protection by partnering with government entities, other non-profit organizations, and individual landowners. In 2013 the Waite Hill Land Conservancy merged with WRLC transferring 300 acres of conservation easements in the Village of Waite Hill, Lake County.

8 Cultural Resources

The Chagrin River watershed is part of the historic Connecticut Western Reserve. The Connecticut Western Reserve was land claimed by Connecticut after the Revolutionary War that stretched west from Connecticut to northeastern Ohio. Congress granted Connecticut a portion of its claim in 1786, and in 1792, Connecticut gave 500,000 acres of that land to citizens whose homes were burned during the American Revolution. In 1795, the Connecticut Land Company bought the remaining land in order to resell it and Cleveland was established in 1796 as the first permanent settlement in the reserve. In 1800, Connecticut and the United States agreed to make the Western Reserve part of the Ohio Territory. Many of the areas of the Chagrin River watershed, particularly those in Cuyahoga County were settled at this time and numerous historic structures and land development traditions remain. Below is listed the extent of historic and archaeological features in the watershed as listed by the Ohio Historic Preservation Office.

8.1 Ohio Archaeological Inventory

The Ohio Archaeological Inventory records prehistoric and historic archaeological sites. One hundred and thirty (130) locations are noted in the Ohio Archaeological Inventory in the Chagrin River. Due to the sensitive nature of these archaeological sites these sites are not shown on a map.

8.2 National Register of Historic Places

The National Register of Historic Places is the official list of properties recognized by the federal government as worthy of preservation for their local, state, or national significance in American history, architecture, archaeology, engineering, or culture. Listed properties may include buildings, sites, structures, or objects worthy of being preserved. Although the National Register is a program of the National Park Service, it is administered at the state level by the Ohio Historic Preservation Office. There are 38 listed sites on the National Register in the watershed, nine of which are historic districts.

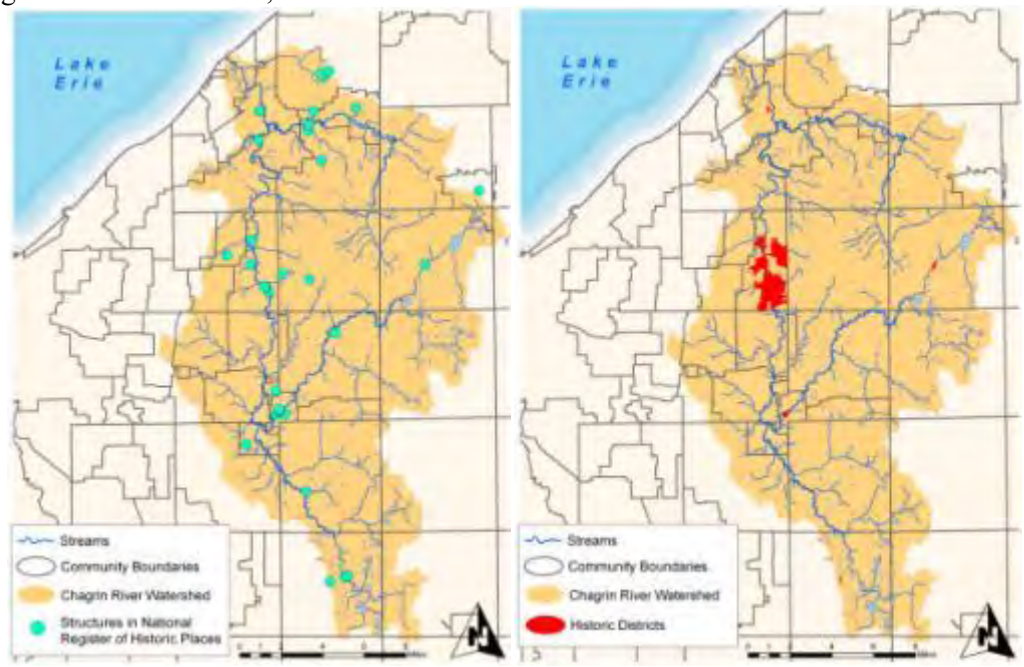


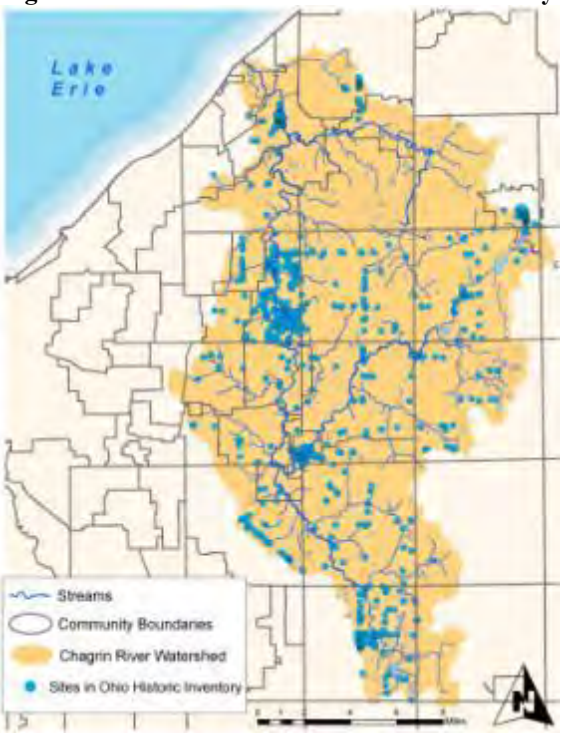
Figure 19: Structures and Historic Districts in the National Register of Historic Place

8.3 Ohio Historic Inventory

The Ohio Historic Inventory program records places of historic or architectural merit and was developed to serve as an accurate and continuing record of the architectural and historic properties currently existing in Ohio. Since 1974, over 70,000 historic properties have been entered into the records of the Ohio Historic Inventory. In the Chagrin, 1,206 places are listed on the Ohio Historic Inventory, further highlighting the rich

historic and cultural setting in the watershed. Figure 20: Structures in Ohio Historic Inventory**Error! Reference source not found.** shows the features on the Ohio Historic Inventory.

Figure 20: Structures in Ohio Historic Inventory



9 Point Source Pollution

Point sources are those direct discharges to streams, wetlands and lakes from industrial discharges or sanitary sewage treatment plants. The National Pollutant Discharge Elimination System (NPDES) permit program controls water pollution by regulating point sources that discharge pollutants into waters of the United States. In addition to permitted point source discharges, a break of sewer line on Aurora Branch of the Chagrin River causing non attainment along this segment of the Chagrin River in 1995. The following sources have NPDES Permits from Ohio EPA that allow them to discharge pollutants to the Chagrin River and its tributaries in certain numeric boundaries. Figure 21 and Table 14 show the regulated point source discharges in the watershed. Additional dischargers that are regulated through the local health departments and the House Bill 110 Programs may not be represented.

Figure 21: WWTP in Chagrin Watershed

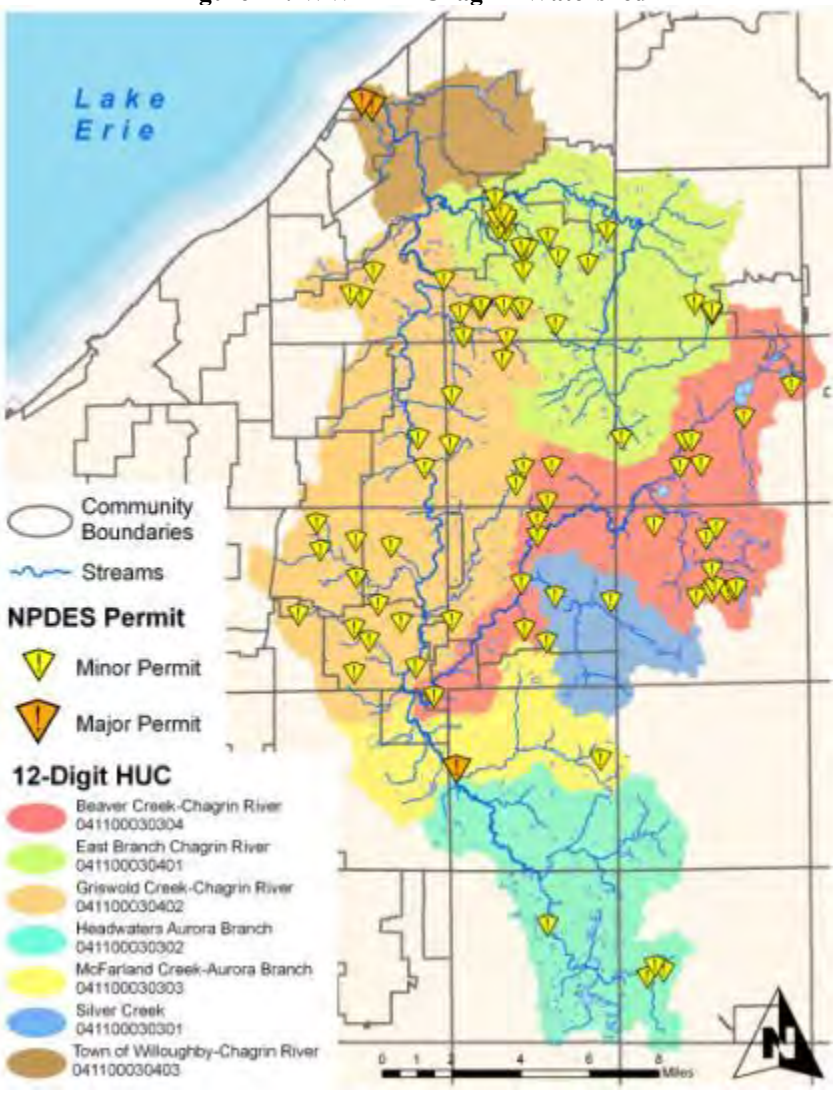


Table 14: Regulated Point Sources in the Chagrin River Watershed

Point Source	Location	12 Digit HUC	Comments
Board of Education	Chester Township – Upper Main Branch	041100030304	Additional information not available.
BP Amoco Oil Corp Bulk Plant Chagrin Falls	Chagrin Falls – Upper Main Branch	041100030304	Additional information not available.
Camp Ho Mita Koda	Newbury – Upper Main Branch	041100030304	6,250 GPD, equalitzation, aeration, sand filters, chlorination, dechlorination
Chagrin Falls Meadow Lane WWTP	Chagrin Falls - Upper Main Branch	041100030304	Additional information not available.
Chagrin Falls Solon Road WWTP	Chagrin Falls – Upper Main Branch	041100030304	1 mgd capacity, possibly undersized for average daily flows and large rain/snow melt events.
Chardon WWTP	Chardon – Upper Main Branch RM 28.3	041100030304	Additional information not available.
Chester Assoc CO Channel Prod	Chester Township	041100030304	Additional information not available.
Chester Rentals	Chester Township – Upper Main Branch	041100030304	Additional information not available.
Claridon Shopping Center	Claridon – Upper Main Branch	041100030304	Additional information not available.
Diversey Water Technologies Inc	Chagrin Falls – Upper Main Branch	041100030304	Additional information not available.
Fowlers Mill WWTP	Munson - Upper Main Branch	041100030304	8,000 GPD, aeration, sand filter, chlorinator with dechlorination
Gastown 3512	Newbury – Upper Main Branch	041100030304	Additional information not available.
Geauga County - Kimberly Estates WWTP	Newbury – RM 42.55 trib. to Upper Main Branch at RM 1.77, 0.89	041100030304	46,000 gallons/day capacity with significant capacity remaining. Sludge disposed at McFarland Creek WWTP. Issues with chlorine residual, dissolved oxygen and ammonia.
Geauga County Belle Vernon Subdivision WWTP	Russell Township - Upper Main Branch	041100030304	40,000 gallons/day capacity. Sludge disposed at McFarland Creek WWTP.
Geauga County Opalocka WWTP	Chester Township – RM 38.32 trib to Upper Main Branch at RM 3.2	041100030304	155,000 gallons/day plant capacity. In 2005, noted frequent overflow and bypassing of treatment. Sludge disposed at McFarland Creek. Upgrades scheduled for 2011 that include replacement of old filters with a new hydroclear sand filter, adding a new digester tank, and converting the old digester into an equalization tank.

Point Source	Location	12 Digit HUC	Comments
Geauga County Russell Park WWTP	Russell Township – Upper Main Branch RM 33.6	041100030304	Serves Russell Park, Hackamore Woods, and Hodgedale Estates with 80,000 gallons/day capacity. In 2005, sand filters are plugged allowing bypass of treatment. Sludge disposed at McFarland Creek WWTP.
Geauga County Scranton Woods WWTP	Newbury – Upper Main Branch	041100030304	14,000 gpd, aeration, sand filters, chlorinator w/dechlorination. Many permit violations for chlorine residual and dissolved oxygen, TSS, CBOD, and ammonia in 2004.
Geauga County Wenhaven Subdivision WWTP	Russell Township - Upper Main Branch	041100030304	7,000 gallons/day capacity remaining. Sludge disposed at McFarland Creek WWTP.
Green Acres Tavern	Newbury – Upper Main Branch	041100030304	Additional information not available.
Gulf Oil	Chester – Upper Main Branch	041100030304	Additional information not available.
Haveter Sand & Gravel Co Ravenna Road Plant	Chardon – Upper Main Branch	041100030304	Additional information not available.
Heather Hill Hospital WWTP	Munson – Beaver Creek RM 0.82	041100030304	0.1 mgd capacity, expanded in 2003, further testing needed since expansion to evaluate phosphorus limit effectiveness.
Kinetico, Inc.	Newbury - Upper Main Branch	041100030304	Industry with on-site wastewater treatment plant, sludge handling, and fire pond.
Manfredi Motor Terminal	Newbury– Dewdale Creek	041100030304	Additional information not available.
Meadow Lane WWTP	Chagrin Falls, Upper Main Branch.	041100030304	Capacity of 1 million gallons/day (MGD) with average flow in 1997 at 1.02 MGD. On-going stormwater infiltration problem.
Newbury High School	Newbury – Dewdale Creek	041100030304	30,000 GPD, equalization, aeration, sand filters, chlorination, dechlorination, improper dechlorinaiton
ODNR	Newbury – Upper Main Branch	041100030304	Additional information not available.
ODNR	Newbury – Upper Main Branch	041100030304	Additional information not available.
ODNR	Newbury – Upper Main Branch	041100030304	Additional information not available.
ODNR Cabin Plant and Lodge	Newbury – Upper Main Branch	041100030304	Additional information not available.
PC Tavern WWTP	Newbury – Dewdale Creek	041100030304	1,750 GPD, equalization, aeration, sand filters, chlorination, dechlorination, began operation this system January 20’04 to replace failing HSTS.
Ricca Plaza	Newbury – Dewdale Creek	041100030304	3,000 GPD, equalization, aeration, sand filters, chlorination, dechlorination

Point Source	Location	12 Digit HUC	Comments
Riverview Church	Russell Township – Upper Main Branch	041100030304	Additional information not available.
Russell Township Service Garage	Russell Township – Upper Main Branch	041100030304	Permitted for wastewater treatment and oil/water separator.
Sisters of Notre Dame Education Center	Chardon Township – Upper Main Branch	041100030304	40,000 GPD, aeration, sand filters, uv disinfection, chlorinator, dechlorination
Speedway SuperAmerica WWTP	Newbury – Dewdale Creek	041100030304	1,500 GPD, equalization, aeration, sand filters, chlorination, dechlorination, started operation in August 1999.
Sycamore Lakes Inc Alpine Valley	Chester Township – Upper Main Branch	041100030304	Additional information not available.
Union Oil Co	Russell Township	041100030304	Additional information not available.
Wintergreen STP	Chardon – Upper Main Branch	041100030304	Additional information not available.
ASM International	Russell Township-Silver Creek via RM 3.5 tributary	041100030301	4,000 GPD, aeration, equalization, sand filters, chlorination, dechlorination
Geauga County Surrey Downs	Russell Township - Silver Creek RM 1.8	041100030301	10,000 gallons/day capacity for 18 units. Sludge disposed at McFarland Creek WWTP. Extended aeration, flow equalizations, sand filters, and UV.
Music St Car Wash	Chagrin Falls – Silver Creek	041100030301	Additional information not available.
Ports Petroleum Co Inc	Russell Township –Silver Creek	041100030301	Additional information not available.
Aurora Central WWTP	Aurora – Lower Aurora Branch RM 11.15	041100030303	1.5 mgd, tertiary, grit removal, flow equalization, aeration, sand filters, post-aeration, sludge holding, UV disinfection, violations of total phosphorous and recoverable copper
BP Oil Co	Bainbridge Township	041100030303	Additional information not available.
Geauga County McFarland Creek WWTP (OH0043494)	Bainbridge - Lower Aurora Branch RM 3.46	041100030303	In 2005, constructed septage receiving station and expanded to 1.8 MGD utilizing new bioreactor membrane filtration system technology.
Kenston Board of Education	Bainbridge – Lower Aurora Branch	041100030303	Additional information not available.
Swagelok Company	Solon – Lower Aurora Branch	041100030303	Additional information not available.
Aurora Acres STP	Ravenna – Upper Aurora Branch	041100030302	Additional information not available.
Aurora Four Seasons STP	Aurora – Upper Aurora Branch	041100030302	Additional information not available.
Aurora Jackson Rd STP	Aurora – Upper Aurora Branch	041100030302	Additional information not available.
Bainbridge Union 76	Bainbridge Township – Upper Aurora Branch	041100030302	Additional information not available.

Point Source	Location	12 Digit HUC	Comments
Cantex Inc	Mantua – Upper Aurora Branch	041100030302	Manufacture PVC, non contact and cooling water 272,000 GPD, sanitary flow 1,000 GPD. In 2003 and 2005, violations for sanitary for CBOD, ammonia, TSS, and oil and grease.
Funtime aka Geauga Lake Park WWTP	Aurora – RM 6.78 trib. to Upper Aurora Branch at RM 0.70	041100030302	155,000 GPD, equalization, aeration, clarifier, sand filters, UV disinfection. Discharges into wetland. Park closed as of 2008.
Jackson Road STP/Central WWTP	Aurora – Upper Aurora Branch	041100030302	Capacity of 1.5 MGD with average flow in 1997 of 750,000 gallons/day. Infiltration and inflow of ground water a significant concern.
Lamson & Sessions Company/Aurora Plant	Mantua Township - Upper Aurora Branch	041100030302	Permit limits for process non-contact water, stormwater, cooling water, and STP effluent.
Lucas Aerospace Power Equipment Corp	Aurora – Upper Aurora Branch	041100030302	Additional information not available.
Rockin Robin Association WWTP	Mantua – Upper Aurora Branch	041100030302	Mobile home park 0. 66 gpd, aeration, equalization, sand filters, chlorinator, dechlorination, sludge holding, 2005 violation of TSS and doesn't treat for phosphorus that may cause enrichment DS
Sneakers Bar and Grille	Solon – Upper Aurora Branch	041100030302	Additional information not available.
Uno Ven 76 Service Station	Chagrin Falls – Upper Aurora Branch	041100030302	Additional information not available.
Yogi Bear's Jellystone Park WWTP	Mantua Township - Upper Aurora Branch	041100030302	30,000 GPD, aeration, sand filters, equalization, UV disinfection. In 2002 exceeded phosphorus, residual chlorine, DO, pH, and TSS permit limits.
Bud Industries Inc	Willoughby	041100030402	Additional information not available.
Chagrin Valley Country Club	Chagrin Falls - Main Branch	041100030402	Additional information not available.
Chagrin Valley Hunt Club	Gates Mills - Main Branch	041100030402	Additional information not available.
Convenient Food Mart No 3-039	Kirtland - Main Branch	041100030402	Additional information not available.
Country Club Inc	Pepper Pike - Main Branch	041100030402	Additional information not available.
Dream Estates WWTP	Russell Township - Main Branch	041100030402	Additional information not available.
Endura Plastic	Kirtland - Main Branch	041100030402	2,000 GPD, aeration chamber, sand filter chlorinator

Point Source	Location	12 Digit HUC	Comments
Gates Mills WWTP	Gates Mills – RM 16.9 to Main Branch	041100030402	15,000 GPD, flow equalization, aeration, media filters, sand filters, chlorination, dechlorination, flow bypassing treatment, with recurring effluent violations
Geauga County - Scarsdale Subdivision WWTP	Russell Township – RM 24.91 trib to main stem at RM 0.84	041100030402	Serves 74 units, ½ in Chagrin Falls with 26,000 gallon/day capacity. Capacity violations due to stormwater infiltration. Sludge disposed at McFarland Creek WWTP. Treatment is flow equalization, aeration, sand filters, UV disinfection
Geauga County Valley View WWTP	Chester Township - Griswold Creek	041100030402	200,000 GPD to serve commercial areas, a few low dissolved oxygen values.
Geauga County Willow Hills Subdivision WWTP	Chester Township - Caves Creek at RM 4.2	041100030402	13,000 GPD, flow equalization, aeration, clarifiers, media filters, sand filters, chlorination, dechlorination. Sludge disposed at McFarland Creek WWTP, violations of chlorine residual, TSS and dissolved oxygen. They are going to switch to UV disinfection.
General Electric Co Chesterland Lamp Plant	Chester Township - Main Branch	041100030402	Additional information not available.
Hawken School WWTP	Gates Mill – Main Branch	041100030402	15,000 GPD, aeration, sand filters, chlorinator
Heathermore STP	Moreland Hills - Main Branch	041100030402	Additional information not available.
Hiram House Camp	Chagrin Falls - Main Branch	041100030402	Additional information not available.
Hocking Valley Resources Co	Pepper Pike - Main Branch	041100030402	Additional information not available.
Holly Hill Nursing Home WWTP	Main Branch	041100030402	15,000 GPD, equalization, aeration, sand filters, chlorination and dechlorination
Jackson Road Subdivision WWTP	Moreland Hills - Main Branch via Willey Creek	041100030402	Capacity less than 100,000 gallons/day.
Johnsonite	Chagrin Falls Twp - Main Branch	041100030402	Additional information not available.
Kirtland Shenandoah Estates WWTP	Kirtland – Caves Creek at RM 3.34	041100030402	12,500 GPD, aeration, sand filters, chlorination, constructed wetland.
Lake County Dodd's Hill STP	Willoughby - Main Branch	041100030402	Additional information not available.
Lake County Land Improvement	Chester - Main Branch	041100030402	Additional information not available.
LFE Instruments	Chester - Main Branch	041100030402	Additional information not available.
Lindahl Plastics Corp	Chester	041100030402	Additional information not available.

Point Source	Location	12 Digit HUC	Comments
Manakiki Golf Course Club House	Willoughby Hills - Main Branch	041100030402	Part of Cleveland Metropark's North Chagrin Reservation. Plant size 10,000 gallons/day. Aeration Chamber
Mario Fazio's Restaurant	Willoughby Hills, Main Branch	041100030402	Additional information not available.
Metzenbaum Opportunity School	Chester Township - Main Branch	041100030402	20,000 GPD, needs upgrades to meet final effluent limitations
Mogul Corp	Chagrin Falls - Main Branch	041100030402	Additional information not available.
Moreland Hills Jackson Valley WWTP	Moreland Hills – Willey Creek RM 2.01	041100030402	60,000 GPD, flow equalization, aeration, sand filters, clarification, chlorination, dechlorination, daily flow exceeds design capacity – *Scheduled for conversion to pump station and connection to NEORSD Easterly WWTP via SOM Center Road Relief Pipe by April 2012*
Moreland Hills Quail Hollow STP	Moreland Hills - RM 23.93 trib to Main Branch at RM 0.86	041100030402	20,000 GPD, aeration , sand filters, chlorination, dechlorination – *Scheduled for conversion to pump station and connection to NEORSD Easterly WWTP via SOM Center Road Relief Pipe by April 2012*
Moreland Hills Woodland Glen WWTP	Moreland Hills - Pepper/Luce Creek at RM 2.17, 0.34	041100030402	80,000 GPD, flow equalization, aeration, clarifiers, media filters, sand filters, UV disinfection – *Scheduled for conversion to pump station and connection to NEORSD Easterly WWTP via SOM Center Road Relief Pipe by April 2012*
Moreland Hills Greentree STP	Moreland Hills - Main Branch at RM 25.77	041100030402	10,000 GPD, flow equalization, aeration, clarifier, media filters, sand filters, chlorination, dechlorination. Hillside erosion threatening plant structure.
Pepper Pike County Club	Pepper Pike – RM 22.81/Pepper/Luce Creek	041100030402	Additional information not available.
Pepper Pike Creekside WWTP	Pepper Pike – RM 22.81/Pepper/Luce Creek at RM 3.43	041100030402	*Scheduled for conversion to pump station and connection to NEORSD Easterly WWTP via SOM Center Road Relief Pipe by April 2012*
Pepper Pike Pepper Hill WWTP	Pepper Pike – RM 22.81/Pepper/Luce Creek at RM 5.59	041100030402	*Discharge eliminated December 31, 2006*
Pittsburgh & Ohio Coal Co	Chagrin Falls – Main Branch	041100030402	Additional information not available.
Union Oil Co	Chester Township - Main Branch	041100030402	Additional information not available.
University School	Village of Hunting Valley - Main Branch	041100030402	Additional information not available.

Point Source	Location	12 Digit HUC	Comments
Ursuline College	City of Pepper Pike - Main Branch	041100030402	Additional information not available.
West Geauga Local School	Chester Township - Main Branch	041100030402	60,000 GPD, aeration, sand filters, equalization, chlorinator, dechlorination Problems with inflow and infiltration.
Willoughby Hills City Hall	Willoughby Hills - Main Branch	041100030402	2,500 GPD, aeration Chamber, sand filter, chlorinator
Willoughby Hills United Methodist	Willoughby Hills - Main Branch	041100030402	2,500 GPD, aeration Chamber, sand filter, chlorinator
Woodbran Reality WWTP	Woodmere - Willey Creek RM 4.66	041100030402	Serves portions of Villages of Orange and Woodmere and Cities of Pepper Pike and Beachwood. Aeration, clarifiers, sand filters, phosphorus removal, uv disinfection, bypasses sand filters during high flow causing permit violations
Angelo's Pizzeria Inc.	Kirtland – East Branch	041100030401	2,000 GPD, aeration Chamber, Filter bed chlorinator
Berkshire Hills County Club WWTP	Chesterland – East Branch	041100030401	5,000 GPD, aeration, , sand filters, uv disinfection,
BP Oil Company's Chardon Dispensing Station	Chardon Township - East Branch	041100030401	Additional information not available.
Camp Anisfield	Claridon Twp	041100030401	Additional information not available.
Eagle Rd MHP	Kirtland – RM 1.37 trib. Stoney Brook at RM 0.80	041100030401	25,000 GPD, aeration, sand filters, chlorination, dechlorination, permit violations for pH, TSS, chlorine residual
Edgewood Condominiums	Kirtland - Stoney Brook at RM 0.92	041100030401	2,500 GPD, aeration chamber, sand filter chlorinator. Scheduled to be tied into Lake County Mentor WWTP by early 2010.
Geauga County Sherman Hills WWTP	Chester Township – RM 15.87 trib. East Branch at RM 1.93	041100030401	In 2006, abandoned the existing Sherman Hills WWTP and replacing it with a pump station and force main.
Kirtland Banquet Hall	Kirtland - East Branch	041100030401	10,000 GPD, aeration Chamber, sand filter, chlorinator
Kirtland Barn	Kirtland - East Branch	041100030401	2,000 GPD, aeration Chamber, sand filter
Kirtland City Tavern	Kirtland – Stoney Brook RM 3.10	041100030401	2,000 GPD, aeration Chamber, chlorinator, plant was supposed to be updated and was in noncompliance of permit as of June 8, 2005. Scheduled to be tied into Lake County Mentor WWTP by early 2010.
Kirtland Community Center	Kirtland - East Branch	041100030401	9,000 GPD, aeration Chamber
Kirtland MHP	Kirtland – Stoney Brook RM 2.15	041100030401	Additional information not available.
Kirtland Marathon Service	Kirtland - East Branch	041100030401	1,500 GPD, aeration Chamber, sand filter, chlorinator

Point Source	Location	12 Digit HUC	Comments
Kirtland Olde Town Tavern	Kirtland – RM 0.78 to Caves Creek at RM 1.70	041100030401	2,500 GPD, aeration Chamber, clarifier, media filters, sand filter, uv disinfection
Kirtland Reorganized Church	Kirtland - East Branch	041100030401	Additional information not available.
Kirtland Shenandoah Estates STP	Kirtland - East Branch	041100030401	Additional information not available.
Kirtland Shopping Center, LLC	Kirtland - Stoney Brook at RM 0.68	041100030401	6,000 GPD, aeration Chamber, sand filter, chlorinator. Scheduled to be tied into Lake County Mentor WWTP by early 2010.
Kirtland Templeview WWTP	Kirtland - Stoney Brook at RM 1.0	041100030401	Scheduled to be tied into Lake County Mentor WWTP by early 2010.
Lake Farmpark	Kirtland – East Branch	041100030401	10,000 GPD, aeration Chamber, sand filter, chlorinator
Lake Metroparks Penitentiary Glen Nature Center	Kirtland – RM 1.1 trib Stoney Brook at RM 0.6	041100030401	5000 gpd, aeration chamer, sand filter, chlorinator, constructed wetland
Latter Day Saints Church Visitor Center	Kirtland - East Branch at RM 2.85	041100030401	5,000 GPD, aeration, sand filters, chlorinator, post aeration. Scheduled to be tied into Lake County Mentor WWTP by early 2010.
Leader's MHP	Chester – East Branch	041100030401	Additional information not available.
Night Flight Lounge	Kirtland – East Branch	041100030401	Additional information not available.
Pneumatic Specialties Inc.	Kirtland –East Branch	041100030401	2,500 GPD, aeration Chamber, sand filter, chlorinator
Rich Oil #3201	Kirtland	041100030401	2,000 GPD, aeration Chamber, sand filter, chlorinator
Rockwood Ledges Subdivision STP	City of Kirtland – East Branch	041100030401	Serves Rockwood and Ledgewood Drives.
The Kirtland Car Company	Kirtland – East Branch	041100030401	1,500 GPD, aeration Chamber
West End Express WWTP	East Branch	041100030401	2,100 GPD, equalization, aeration, sand filters, chlorinator, permit violations for dissolved oxygen, TSS, CBOD, ammonia
Western Reserve Healthcare	Kirtland – Stoney Brook RM 1.8	041100030401	41,000 GPD, flow equalization, aeration, clarifiers, media filters, sand filters, chlorination, dechlorination
Wilder MHP S	Chardon – East Branch	041100030401	Additional information not available.
Willoughby Hills Auto Care	Kirtland – East Branch	041100030401	1,500 GPD, aeration Chamber
Yops Time Out Grill	Chardon – East Branch	041100030401	3,500 GPD, flow equalization, aeration, sand filters, chlorinator
Hilltop Apartments	Kirtland - Stoney Brook	04110003-04-01	20,000 GPD, aeration Chamber, sand filter chlorinator, small number of violations for dissolved oxygen, ammonia, and chlorine residual

Point Source	Location	12 Digit HUC	Comments
Hilltop Center	Kirtland - East Branch	04110003-04-01	1,500 GPD, aeration Chamber, sand filter
Holden Arboretum	Kirtland – East Branch	04110003-04-01	>10,000 GPD, aeration chamber, sand filter chlorinator
Kirtland City Hall	Kirtland - Stoney Brook	04110003-04-01	2,000 GPD, aeration Chamber, sand filter, chlorinator
Kirtland Hickory Hill Colony Subdivision	Kirtland – RM 1.0 trib Stoney Brook at RM 2.10	04110003-04-01	30,000 GPD, aeration, sand filters, chlorination, dechlorination.
Kirtland Local School	Kirtland – RM 1.85 trib. Quarry Creek at RM 0.47, 0.6	04110003-04-01	30,000 GPD, aeration, sand filters, chlorination, dechlorination. Scheduled to be tied into Lake County Mentor WWTP by early 2010.
Kirtland Mobile Homes	Kirtland - Stoney Brook	04110003-04-01	20,000 GPD, aeration Chamber, sand filter, chlorinator
Kirtland Plaza Inc	Kirtland – RM 1.85 trib Quarry Creek at RM 0.47 trib at 0.50	04110003-04-01	10,000 GPD,aeration, sand filters, chlorinator. Scheduled to be tied into Lake County Mentor WWTP by early 2010.
Beaver Creek Colony STP	Mentor – Lower Main Branch	041100030403	Additional information not available.
Care Auto Service Inc	Willoughby – Lower Main Branch	041100030403	Additional information not available.
Daniels Bros Fuel Co	Willoughby – Lower Main Branch	041100030403	Additional information not available.
Deena's Half Acres STP	Mentor - Lower Main Branch	041100030403	Additional information not available.
French Hollow Subdivision No 9 STP	Mentor - Lower Main Branch	041100030403	Additional information not available.
Kalcor Coatings Co	Willoughby – Lower Main Branch	041100030403	Additional information not available.
Lorrey Village STP	Mentor - Lower Main Branch	041100030403	Additional information not available.
Russell Burdsall & Ward Inc RB & W Bolt and Nut Co	Mentor – Lower Main Branch	041100030403	Additional information not available.
Sherman Ind Inc	Willoughby – Lower Main Branch	041100030403	Additional information not available.
Willoughby-Eastlake WWTP (OH0028126)	City of Eastlake – Lower Main Branch	041100030403	Additional information not available.

10 Nonpoint Source Pollution and Programs to Manage

The greatest on-going threat to the Chagrin River watershed's quality continues to be nonpoint pollution sources. Nonpoint source pollution is caused by rainfall or snowmelt moving over and through the ground. As the runoff moves, it picks up and carries away natural and human-made pollutants, finally depositing them into lakes, rivers, wetlands, and even our underground sources of drinking water. These pollutants are numerous and include: excess fertilizers, herbicides, and insecticides from agricultural lands and residential areas; oil, grease, and toxic chemicals from urban runoff and energy production;

sediment from poorly managed construction sites, crop and forest lands, and eroding stream banks; bacteria and nutrients from livestock, pet wastes, and faulty septic systems.

The Chagrin River watershed is impacted by nonpoint pollution from urban/suburban development including failing septic systems, sedimentation due to stormwater runoff and stream bank erosion, riparian encroachment, and other habitat alterations. According to the Ohio EPA, the nutrients and sediments entering the Chagrin River and its tributaries could damage its high overall water and habitat quality. All of these nonpoint sources are linked to land use changes. Controls for nonpoint source pollution and the partners that work with nonpoint source programs area discussed below.

10.1 Stormwater Management

Many of the water quality problems in the Chagrin River watershed are directly linked to water quantity issues resulting from increased urbanization and related stormwater runoff. As stormwater is generally how nonpoint source pollution reaches the stream, many of the programs and organizations that assist to manage stormwater pollution also provide services to manage many of the nonpoint source pollutants. Stormwater runoff during rainfall and snow events often contains pollutants in quantities that adversely affect water quality. Ineffective stormwater management practices can lead to increased peak stream flows, stream channel alterations and stream bank erosion due to increased flows, flooding, and nutrient loads. The Ohio EPA and local governments regulate stormwater. This section highlights the programs and organizations that assist communities to manage stormwater.

10.1.1 Low Impact Development and Green Infrastructure

CRWP has worked with communities within the watershed on updating stormwater management codes to allow more innovative stormwater management and to promote stormwater retrofits. In addition the concepts of low impact development (LID) and green infrastructure consider stormwater management from the beginning of a development plan and strive to manage stormwater in a manner that mimics the natural storage and infiltration treatment of stormwater. In 2006, CRWP was granted funding by the USEPA National Community Decentralized Demonstration Project to assist Members in implementing innovative stormwater management techniques. These techniques are collectively referred to as low impact development and include conservation development, riparian and wetland setbacks, and structural stormwater practices, such as bioretention cells, rain gardens and pervious pavements. These practices can address existing flooding, erosion, or water quality problems or improve new development. This project includes technical support, education, and funding to design, construct, and monitor four low impact development demonstration projects. Information gathered from these demonstrations will address concerns about the role of soils, climate, and maintenance in the applicability of these practices to Ohio. CRWP has worked with our members to develop numerous demonstration projects and more information and videos of these projects can be viewed on CRWP's website at www.crwp.org.

10.1.2 NPDES Phase II

Historically, stormwater management has focused on controlling large storms and flooding concerns. In response to the 1987 Amendments to the CWA, the USEPA developed Phase I of the NPDES Stormwater Program in 1990. Under Phase I, USEPA required NPDES permits for stormwater discharges from medium and large municipal separate storm sewer systems (MS4s) in communities with populations of 100,000 or more; and for 11 categories of industrial activity that includes construction activity that disturbs five or more acres of land. In 1999 the USEPA expanded the Phase I program under the Phase II program. The NPDES Phase II ruling includes operators of small MS4s in urbanized areas, or UAs, (as determined by the Bureau of the Census) and operators of small construction activities that disturb greater than one acre and less than 5 acres, in addition to the currently regulated sites of greater than 5 acres. The affected communities in the Chagrin River watershed are detailed in

Table 2 and
Table 3. Phase II communities developed stormwater programs in March 2003 to implements the following six minimum control measures:

1. Public Education and Outreach
2. Public Participation and Involvement
3. Illicit Discharge Detection and Elimination
4. Construction Site Runoff Control
5. Post-Construction Runoff Control
6. Pollution Prevention and Good Housekeeping

All construction sites greater than one acre are affected by the small construction sites segment of the Phase II Regulations under Ohio EPA's general construction permit. As of 2011 90% of CRWP Member communities adopted updated erosion and sediment control and stormwater management regulations that require submission of stormwater pollution prevention plans (SWP3s) and local implementation and maintenance of BMPs. As stated in the Total Maximum Daily Load (TMDL) report, Ohio EPA intends to develop a basin specific stormwater permit for construction activities. Additional requirements in this permit could include riparian setbacks, runoff reduction, groundwater recharge requirements, BMP selection to protect the thermal regime in cold water stream drainage areas, and more stringent sediment and erosion controls that include performance standards. In Geauga County, the Geauga Soil and Water Conservation District (SWCD) has rules that regulate these activities. In Lake, Cuyahoga, and Portage Counties, a combination of community regulation and cooperative agreements with SWCDs are used to meet the requirements of these regulations.

As communities manage stormwater and comply with NPDES Phase II regulations, local organizations, such as CRWP, SWCDs, and Health Departments have worked together to provide services ranging from education to plan/code review and illicit discharge detection and elimination. The NPDES Phase II program requires that local governments bear all of the costs associated with the new regulations, so several communities and regions have formed stormwater utilities to assist in funding the maintenance of the stormwater infrastructure throughout the watershed. The fees are charged on individual parcels of land based on the amount of impervious area on the property.

10.2 Lake County Stormwater Management Department

The mission of the Lake County Stormwater Management Department (LCSMD) is to enhance the quality of life in Lake County using education, science and technology to protect stormwater quality. In response to NPDES Phase II requirements, Lake County formed a Stormwater Management Department in August 2003. The Department has 15 member communities that receive services including:

- Kirtland
- Kirtland Hills
- Willoughby Hills

The Lake County Engineer has identified the range of stormwater management services needed in Lake County to meet Ohio EPA's Phase II permit conditions and address critical drainage problems. The Chagrin communities listed above receive administrative and regulatory compliance support, data collection, maintenance, planning, and capital projects to properly manage regional water courses and drainage infrastructure; and a full suite of Ohio EPA Phase II stormwater permit compliance services. Under this service level option, local communities would continue to be responsible for capital improvements and maintaining local drainage systems. LCSMD has also developed a credit manual for non-residential users. The credit is a calculated reduction in the stormwater user fee for a developed

property in one of the LCSMD's member communities. Those properties that either reduce their impact on the downstream stormwater system by decreasing runoff or pollution, or that directly reduce the Department's program costs may be eligible for a credit.

10.3 Northeast Ohio Regional Sewer District

Since 1998, the Northeast Ohio Regional Sewer District (NEORSD) has conducted several stormwater studies, which indicate the potential need for up to $400 million in capital improvements and remedial maintenance projects for regional flooding and erosion problems and water quality concerns. As of 2013, this program was pending a review of NEORSD authorities by the Ohio Supreme Court. If fully implemented, NEORSD's stormwater program will provide assistance along the stormwater system in their service area, model and plan solutions, inspect and maintain streams, pipes, and culverts, construct stream restoration to control erosion, construct projects to address flooding and water quality, stormwater permit compliance assistance, technical guidance and training, public education and improved floodplain management. The NEORSD stormwater program includes a residential and nonresidential credit program to allow property owners to lower their fees based on stormwater management activities.

10.4 Portage County Stormwater District

In 2009, the Portage County Board of Commissioners established a Stormwater District to assist in achieving compliance with the requirements of the Phase II program. All properties within unincorporated Portage County are included in the Stormwater District. Although many of the required administrative duties are behind the scenes, residents and businesses receive additional public education programs, illicit discharge elimination efforts, stormwater and erosion control regulation for construction sites, and maintenance of post-construction stormwater quality facilities. Services provided by the Stormwater District are through the County Engineer, SWCD and Health Department.

10.5 Cuyahoga County SWCD

Cuyahoga SWCD mission is to promote conservation of land and aquatic resources through stewardship initiatives, education programs and technical assistance. Cuyahoga SWCD provides landowner assistance to Cuyahoga County residents. Cuyahoga SWCD does not administer stormwater rules countywide, but they review stormwater post construction BMP design using NRCS standards. Cuyahoga SWCD provides technical guidance to home owners related to erosion and sediment control, drainage and stream-related issues, soils information and hillside slippage. In addition, Cuyahoga SWCD provides technical guidance to municipalities, on a limited basis, related to erosion, sediment, non-sediment pollutant control, and post-construction BMPs, drainage and stream-related issues, soils information, and hillside slippage. Cuyahoga SWCD is available to conduct construction site inspections and field reviews, on a limited basis, for compliance with all levels of the stormwater pollution prevention regulation. In the Chagrin River watershed, Cuyahoga SWCD does not currently have any agreements with local communities to provide these services.

Cuyahoga SWCD provides a myriad of education opportunities and resources, including work with local schools, educational assistance at environmental events, including activities and exhibits, teacher workshops geared to state mandated science standards, and fact sheets and brochures about conservation topics. Finally, the Cuyahoga SWCD also employs watershed coordinators for the Euclid Creek and Rocky River watersheds. The Euclid Creek watershed and the Chagrin River watershed split several communities, Mayfield Heights, Mayfield Village, and Willoughby Hills, thus efforts undertaken in these communities can benefit both the Chagrin and Euclid Creek watersheds.

10.6 Lake County SWCD

The Lake County SWCD provides many services to both communities and individual residents through their educational programs, urban program, and special projects. The District's Urban Programs focus on

protecting the county's natural resources through education, technical assistance, and administration of county and municipal erosion and sediment control ordinances. This program includes advising landowners, developers, realtors, engineers, and community administrations on erosion and sediment control plans, stormwater reviews, education and technical assistance. The Lake SWCD also provides technical assistance to landowners with flooding or erosion issues, ponds, streams, ravines, and forests. In the Chagrin River watershed the Lake SWCD administers erosion and sediment control ordinances for the Cities of Wickliffe, Kirtland, Willoughby Hills, and Eastlake. In the Cities of Willoughby, Mentor, and Willowick, Lake SWCD provides review services upon request.

Although the Lake SWCD holds conservation easements in Lake County, they currently do not hold any in the Chagrin River watershed. Lake SWCD has worked with property owners and volunteers to complete several bank stabilization projects and wetland restoration. These include evergreen tree revetments along the East Branch of the Chagrin at Wisner Road (including willow plantings), along Pierson's Creek at the Holden Arboretum, and along the main stem of the Chagrin at Eagle Road and Chagrin River Drive. Lake SWCD promoted wetland restoration activities at the Holden Ridge Subdivision through on site wetland mitigation of a forested wetland. Lake SWCD will continue to work with CRWP, Lake SMD and others to facilitate stream and wetland restoration. Lake SWCD offers education outreach to residents of all ages on a wide variety of natural resources topics. Yearly, over 100 programs are scheduled with schools, after-school clubs, and adult groups.

In 2003 and 2004, Lake SWCD worked with various conservation organizations and county agencies to post signs identifying some of the important headwater streams in the county. As of December 2004, there were 44 stream crossings with watershed signs, 10 of which are located in the Chagrin River watershed. Lake SWCD also implemented a Headwater Habitat Evaluation (HHEI) Project to do a comprehensive survey of headwater stream health in the County. A web page (http://www.lakecountyohio.org/soil/noframes.htm) allows Lake County residents to have access to the information Lake SWCD has collected.

10.7 Geauga County SWCD

The Geauga SWCD serves the residents of Geauga County by providing many services, including: a biannual fish sale; a tree seedling sale; technical assistance on soils, drainage, erosion, aerial photographs, and GIS; education and public outreach; and review and monitoring of construction sites. The District's Urban Program is set up to review and monitor construction sites in the county to ensure that sediment and erosion control measures are implemented. Geauga County was the first county in Ohio to establish stormwater management and erosion/sediment control regulations in 1979. The purpose of the regulations is to protect the county's water resources by ensuring that the proper stormwater and erosion and sediment control measures are in place. The Geauga SWCD administers these regulations.

The District inspects sites to ensure that the regulations are being followed correctly. Upon implementation of NPDES Phase II regulations, sites greater than one acre are regulated for erosion and sediment control. The District staff works diligently to review plans and perform site inspections to ensure that these erosion and sediment control measures are in place. The District also has an education program that consists of school presentations, teacher workshops, adult outreach, and newsletters.

10.8 Portage County SWCD

The Portage SWCD provides consultations and technical and planning assistance to the agricultural and urban areas of Portage County. Technical assistance is provided in planning, design, and installations of measures for erosion and sediment control, recreation, pollution abatement, and water and land management for wildlife and livestock. The main roles of the Portage SWCD in the county's stormwater program include: public education and information, construction site runoff control, post-construction

stormwater management, permit management and annual reporting. The District is also assisting the regulated communities with illicit discharge mapping and good housekeeping training programs. In the Chagrin River watershed portions of Portage County, the Portage SWCD works on a limited basis with the City of Aurora, but is involved in Mantua Township on a regular basis.

In addition to Phase II activities, the District also runs several programs to educate and provide services the county including: trees and fish stocking sales, cost share programs for landowners to install conservation practices, assistance with drainage, soil erosion, or water issues on private property, farmland preservation, and educational services to teachers, students and community groups.

10.9 Home Sewage Treatment Systems (HSTS)

In Ohio EPA assessments of the watershed, Ohio EPA identified nutrient enrichment as one of the greatest cause of impairment to water quality. In addition to flows from NPDES discharges, on-site septic systems are a significant source of nutrient enrichment in the Chagrin River watershed. Ohio EPA sampling in 2003-2004 showed elevated levels of bacteria in the form of fecal coliforms and E. coli. Although additional data is needed to determine the sources of the elevated bacteria levels, the higher bacterial counts appear to be associated with increased stream flow. This association indicates that the bacteria sources are not from point sources, but rather from nonpoint sources associated with stormwater flows. Thus the potential sources may be natural, agricultural operations, and home sewage treatment systems. Currently data on failing septic systems is not in a format that can be plotted on a map. However, in

Figure **17**, one can see that the 76% of the watershed is planned to be served by On-site wastewater treatment. Thus further inventory and mapping of existing systems and their efficacy is necessary. The following sections detail programs in each of the Chagrin River watershed's four county health departments that address septic issues.

10.10 Cuyahoga County Board of Health

The watershed protection unit of the Cuyahoga County Board of Health (CCBH) is dedicated to protect public health by ensuring that the water quality throughout this region is being monitored and that solutions are found to improve the overall water quality in this region. CCBH actively operates the household sewage, semi-public sewage, stormwater, drinking water, water quality monitoring and educational outreach programs in the Chagrin River watershed.

In 1992, the CCBH established its current Water Pollution Control Program. A broad watershed-based approach is utilized when investigating nuisances and identifying individual pollution sources. In 1993, appendices to the CCBH Sewage Disposal Rules were adopted and included requirements regarding septic system abandonment, aeration system design and maintenance, and the initiation of an Operation and Maintenance Program. In the fall of 1993, the CCBH became one of the first local health departments to launch a Household Sewage Operation and Maintenance Program that includes an on-going nuisance investigation and requested point-of-sale evaluations. In addition, CCBH sanitarians conduct sewage system evaluations upon request, during nuisance investigations, or as a part of a sewage system testing project area. A previous inspection fee has been replaced by the yearly payment of an Operational Permit. An application for the permit is mailed to the property owner on an annual basis prior to the renewal date of September 1st. Upon return to CCBH, the permit applications are sorted and entered into a computer database. All outstanding permit fees are required to be paid prior to the scheduling of a requested sewage system evaluation.

These sewage system evaluation results are combined with water quality sampling data and are provided to local officials. The determination can then be made whether or not a sanitary sewer installation is

practical in a specific area. If it is not, CCBH sanitarians can then proceed with sewage system repair or replacement as necessary to eliminate individual failing systems and the resulting public health concerns. Sanitarians also conduct numerous public information seminars to better educate homeowners using HSTS.

CCBH and Ohio EPA have developed a HSTS Plan that offers financial assistance to homeowners who are being required to upgrade or replace their failing household sewage treatment systems. This low-interest loan program will be administered by CCBH and will utilize funds provided by the Ohio EPA's Water Pollution Control Loan Fund (WPCLF). The program assists homeowners as they upgrade or replace their existing sewage treatment systems. There are approximately 4,752 HSTS in the Chagrin River Watershed in Cuyahoga County. CCBH has conducted HSTS evaluations and basic system assessments on all these systems. Approximately ten percent of the systems are currently in failure or likely in failure due to their age and design. Sanitary sewers will be installed in sections of Mayfield Village, Orange Village, Solon, Bentleyville, and Mayfield Heights over the next 5-8 years and should eliminate a number of HSTS. The remaining areas will be evaluated on a routine basis and any HSTS found to be in failure would need to be upgraded at that time.

Table 15: Cuyahoga County Residential Septic Systems

Community	Residential Septic Summary (2000)	Residential Septic Summary (2005)
City of Beachwood	61	58
Village of Bentleyville	122	129
Chagrin Falls Township	43	40
Village of Chagrin Falls	71	57
Village of Gates Mills	843	856
City of Highland Heights	510	35
Village of Hunting Valley	227	244
City of Lyndhurst	5	4
City of Mayfield Heights	51	46
Village of Mayfield	314	249
Village of Moreland Hills	946	946
Village of Orange	648	631
City of Pepper Pike	1,531	1,489
City of Solon	558	65
Village of Woodmere	15	0

The following tables detail the information on specific systems in the Chagrin River watershed. Table 16 identifies the number of systems in this watershed in regards to system type. As seen below, nearly 50% of the HSTS are aeration systems.

Table 16: Cuyahoga County Sewage Systems by Design in Chagrin River Watershed

Sewage Systems By Design In Chagrin River Watershed		
DESIGN	**TOTAL NUMBER**	**PERCENT OF ALL SYSTEMS**
Filter Beds	1,582	33.29%
Aeration Systems	2,545	53.56%
Leachfields	97	2.04%
Et Fields	77	1.62%
Unknown	451	9.49%
Total	4,752	100.00 %

Table 17: Cuyahoga County Semi-Public Sewage Systems Permitted by CCBH

Community	# of Systems
Bentleyville	5
Gates Mills	8
Hunting Valley	9
Moreland Hills	11
Orange Village	9
Pepper Pike	7

Table 17 clearly shows that over 60% of the filter bed systems currently in use are over twenty years old and are now a concern because of their age. If we assume that many of the "unknown" systems are in fact filter beds, well over 2,500 of these systems are now at least 20 years of age or older and have the potential to cause public health concerns.

Table 18: Cuyahoga County Aeration Systems by Age of Installation

Aeration Systems By Age Of Installation		
INSTALLATION DATE	**TOTAL NUMBER**	**PERCENTAGE**
Prior To January 1, 1976	200	7.86 %
After January 1, 1976	2,345	92.14 %

Table 18 provides information regarding aeration systems currently being utilized in the Chagrin River Watershed of Cuyahoga County. Over 90% of all aeration systems in use are newer systems. Those aeration systems installed after the mid-1970's are still a concern because they are mechanical systems that require regular maintenance.

Table 19: Cuyahoga County Traditional Leaching Systems

Traditional Leaching Systems		
INSTALLATION DATE	**TOTAL NUMBER**	**PERCENTAGE**

Prior To January 1, 1976	51	52.57 %
After January 1, 1976	46	47.43 %

Table 19 provides information on traditional leaching systems. One can see that only a small number of these systems have been installed in Cuyahoga County in the last twenty years. Older leaching systems were installed in many soil types that were not conducive to the effective treatment and dissipation of household sewage. Traditional leaching systems installed today are specifically designed and approved for use on lots having suitable soil types and no topographical or geological limitations.

The CCBH has developed an extensive stormwater program that allows CCBH to assist watershed communities in meeting their Phase II Stormwater Requirements. This program consists of the following:

- MS4 inventory in communities
- Dry Weather Screening of all MS4 outfall locations during dry weather conditions
- Sampling of Dry Weather Flows
- Educational outreach to school aged children on non-point source pollution and adults
- Good Housekeeping
- Post Construction Inspections

In the Chagrin watershed, CCBH performs outfall sampling in Beachwood, Gates Mills, Highland Hts., Mayfield Hts., Mayfield Village, Orange Village, and Aurora. CCBH conducted source tracking in Beachwood and Mayfield Heights in 2008 and 2009 in order to assist these communities in determining the sources of the potential illicit discharges.

Table 20: Outfalls with >5,000 Fecal Coliform Colonies/100mL

Community	Total Number of Outfalls in Community	# of Outfalls sampled in 2009	# of Outfalls sampled in 2009 >5,000 Fecal Coliform/100mL
Beachwood	75	25	4
Gates Mills	4	3	2
Highland Heights	76	24	5
Mayfield Heights	43	19	6
Mayfield Village	112	30	7
Orange Village	90	25	7
Aurora	699	25	5

10.11 Geauga County General Health District

Residential septic systems in Geauga County have been managed by the Geauga County General Health District (GCGHD) since approximately 1955. In 2001, NOACA conducted a survey of home sewage disposal systems and semi-public sewage disposal systems. In the report, an estimated 8,504 of on–lot HSTS were installed from 1979-1998 with an estimated 33,000 HSTS across the County. In 2009, GCGHD estimated that there are 23,000 systems across the county. Prior to the economic downturn in 2008, an average of 500 new HSTS are being installed each year in Geauga County. As the Chagrin River portion of Geauga County is the fastest growing area of the county, many of these systems are being installed in the Chagrin River watershed. The majority of these systems have a septic tank and a

leaching trench system. The GCGHD Board must approve each new off lot system. During the survey 93 HSTS systems in Geauga County were inspected. Besides pre-existing lots, over 900 malfunctioning septic systems have been updated in the County. Of this 900, 110 went to new on-lot discharging systems while the remaining 790 systems were linked to sanitary sewers. Many areas in the County continue to have malfunctioning septic systems. These areas were identified by the County through written complaints and the best professional judgment of District staff.

A HSTS plan has not been developed for Geauga County. However GCGHD established a mandatory property sale inspection program in 2002. This program requires that any property sale must include an evaluation of the existing HSTS. Approximately 400 inspections are completed each year through this program. According to GCGHD staff 94% of the on-lot leaching trench systems are passing the inspection and are operating correctly. Any systems that do not pass the inspections are required to repair or update the system. Approximately 80-90% of the pre-1960 off-lot systems inspected through this program were found to be failing. If off-lot systems are found to be failing and no space or soils are available for replacing the system with an on-lot system, the Board of Health will allow replacement with an off lot system. New off lot systems must comply with Ohio EPA NPDES for discharging systems. Ninety-eight (98%) of newly permitted systems were found to be passing.

The Village of South Russell has a local ordinance that requires every septic system installed in the Village to be registered with the Building Inspector. Additionally, where a public sewer is available and accessible, septic tank sewage disposal system or an on-site sewage disposal system is prohibited. As of September 1997, every septic system shall be inspected and cleaned at least once every two years.

10.12 Lake County General Health District

The Lake County General Health District (LCGHD) manages HSTS and Semi Public Sewage Treatment Systems in Lake County. These programs involve activities such as site evaluation, design, plan review, installation inspection, and operation and maintenance of household and semi-public systems. LCGHD developed a HSTS Improvement Plan that includes:

- Consultation with experts to investigate alternative system designs
- Development of alternative system design criteria (drip distribution & mounds) with Ohio Department of Health approval for use in Lake County
- Disclosure notices required for trench type sewage systems in severe soils indicating potential risk of failure

Table 21: Lake County Inventory of HSTS

Community	HSTS Summary
Kirtland	All homes with HSTS except for 3 subdivisions.
Kirtland Hills	All homes with HSTS
Mentor	Predominantly served with sanitary sewers, except for small areas.
Willoughby Hills	The majority of the area in the Chagrin River watershed is served by HSTS
Waite Hill	All homes with HSTS
Eastlake	Predominantly served with sanitary sewers, except for Reeves Rd., Rural Dr., spots on Lakeshore Blvd., N. Parkway and Riverside Dr.

Community	HSTS Summary
Willoughby	Predominantly served with sanitary sewers, except for spots on Rt. 84, River Road

The LCGHD HSTS plan enables LCGHD to establish a Linked Deposit Loan Program through Ohio EPA's Water Pollution Control Loan fund. The linked deposit loan program will be used to financially assist homeowners with the replacement of residential sewage treatment systems that are malfunctioning and for the connection to sanitary sewers.

Table 22: Lake County Household Sewage Treatment System Summary

COMMUNITY	TOTAL HSTS PER COMMUNITY	TOTAL OFFLOT DISCHARGE	TOTAL SOIL ABSORPTION	TOTAL DRIP DISTRIBUTION	TOTAL MOUNDS
KIRTLAND	2283	121	2135	5	22
KIRTLAND HILLS	275	12	260	2	1
WAITE HILL	202	6	196	0	0
EASTLAKE	130	2	128	0	0
WICKLIFFE	18	0	18	0	0
WILLOUGHBY	135	3	132	0	0
WILLOUGHBY HILLS	1607	230	1372	4	1
MENTOR	360	4	356	0	0

Since 1988, LCGHD requires bi-annual inspections of sewage systems in all newly established subdivisions. Homeowners, through deed restrictions, must contract privately from a list of subdivision "qualified" HSTS inspectors. The Homeowners Association is also required to ensure that routine maintenance, such as tank pumping, and minor repairs are completed. A copy of the inspection report is sent to the subdivisions Homeowner's Association, the homeowner, and the health district. LCGHD tracks and ensures compliance with the requirements. Existing drip distribution systems must be inspected annually through individual contracts with the service providers.

Currently LCGHD offers a voluntary Point of Sale (POS) sewage system inspection program. Buyers, sellers, lenders and realtors can request the inspections from the district for a fee. If a system is found to be malfunctioning after the inspection is completed by a registered sanitarian, the owners are required to remedy the problem. The homeowner must sign an application form that acknowledges this repair/replacement requirement. Approximately 200-300 POS inspections are done annually.

As part of NPDES Phase II Program, LCGHD has contracted with various communities and public entities to offer services such as: locating and screening of outfalls, water quality testing, illicit discharge detection & elimination, and stormwater education.

As of December 2004, sixteen (16) illicit discharges have been detected and eight (8) have been eliminated throughout Lake County, with a significant amount located in the Chagrin River watershed. Most illicit discharges have been attributed to malfunctioning septic systems and laundry wastewater discharge into ravines, ditches that eventually make their way to a stream or river.

LCGHD has had an active Semi Public Sewage Program since the inception of House Bill 110. Program goals for 2005 are to locate any remaining semi-public systems currently not in the 110 inspection program and take necessary steps to include them and to initiate a internal inspection of business operations, utilizing dye testing for the onsite systems during the routine inspections of those systems.

Table 23: Semi Public Treatment System Summary

COMMUNITY	TOTAL	DISCHARGE	NON - DISCHARGE
KIRTLAND	68	31	37
KIRTLAND HILLS	4	0	4
WAITE HILL	1	0	1
EASTLAKE	2	1	1
WILLOUGHBY	4	2	2
WILLOUGHBY HILLS	9	7	2
MENTOR	3	0	3

10.13 Portage County Combined Health District

The Portage County Combined Health District (PCCHD) is a small county health department with limited resources. The City of Aurora has a mandatory pumping requirement in city limits for HSTS; however, areas of Mantua Township in the Chagrin River watershed are served solely by HSTS and under the jurisdiction of PCCHD. The City of Aurora maintains an on-going septic tank cleaning program. This is completed on a rotating schedule (once every other year) for those homeowners who have completed an Application for Septic System Cleaning. All Town & Country Septic Tank Service has been contracted by the City to perform this service at no cost to the resident.

A HSTS plan has not been developed, but PCCHD has an inspection program for mechanical off lot discharging HSTS. This program requires owners of these systems to maintain a service contract with a qualified inspector to complete inspections two times per year, or to contract with PCCHD to complete these inspections annually. At this time, no on lot inspection program is in place in Portage County. Point of sale inspections are driven by requirements of lending institutions. Unfortunately, these results are not required to be submitted to PCCHD, although several inspectors submit them voluntarily.

In the City of Aurora, 102 aeration HSTS have been installed after 1987 and are monitored annually by either PCCHD or a private contractor. In addition, 52 aeration HSTS have permit with PCCHD, but were installed prior to 1988. These systems may have been eliminated due to sewer extensions, but are not inspected by PCCHD if they continue to exist.

The PCCHD requires that an individual residential lot have an acre and a half of "usable land" for a well, HSTS, and replacement system to be disapproved on the lot. Soil test holes are completed on each lot. If lots are approved, a property owner may obtain a more exhaustive study with a private contractor and lot may be proven to have a suitable amount of area to approve a HSTS for that parcel. Subdivisions are not approved for septic availability until all lots are approved for HSTS and replacement systems. Existing off lot discharging HSTS may be replaced with an on lot HSTS, but these failing systems are largely replaced with mechanical systems that require additional inspection requirements.

Illicit discharge inspections and list of off lot discharging systems may be provided to communities who have completed a memorandum of understanding with PCCHD and will continue under the newly formed

Portage Stormwater District in unincorporated areas of Portage County. There are six (6) small wastewater treatment systems managed by PCCHD under HB 110 in the City of Aurora.

10.14 Local Planning and Zoning Regulations

CRWP has developed model zoning regulations for riparian and wetland setbacks, erosion and sediment control management, stormwater management, conservation development, off street parking, and floodplain management. Adoption and implementation of these model regulations allows a community to maintain the natural flood control, erosion control and water quality functions of intact wetlands, streams, and floodplains. CRWP works with our Member communities, zoning commissions, and Planning Commissions to adapt the model zoning codes to each community. Local zoning should be supported by a community comprehensive land use plan which CRWP strongly recommends. As of December 2009, 100% of Chagrin communities have comprehensive plans, 5 include concepts and maps from the *Chagrin River Watershed Balanced Growth Plan.*

10.14.1Erosion and Sediment Control and Comprehensive Stormwater Management

Ohio EPA requires all owners and operators of construction sites disturbing 1 acre or more, or less than 1 acre if part of a larger common plan of development or sale to obtain a permit from Ohio EPA that includes erosion and sediment control requirements and stormwater quality requirements. Communities that are designated under Ohio EPA's Phase II Stormwater Program are required to ensure their codes meet or exceed Ohio EPA's requirements. All communities should ensure that their erosion and sediment control and stormwater management regulations meet these minimum standards since all construction sites are required to get this permit. Communities should evaluate their existing codes to allow additional stormwater control measures (SCMs) and low impact development strategies such as site design, downspout disconnection, bioretention, and alternative parking arrangements and materials. Furthermore communities can adopt enhanced sediment and erosion control regulations with ability to stop construction work when necessary and lower limits of disturbance that requires compliance.

At the close of 2013, 90% of the watershed, had adopted regulations to control erosion and sedimentation and comprehensive stormwater management regulations that comply with Ohio EPA's Phase II Stormwater Program. CRWP will continue to work with all communities to adopt regulations for erosion and sediment control, comprehensive stormwater management and update existing regulations based on a community's stormwater management concerns.

10.14.2 Conservation Development

Conservation development conserves natural resources while allowing for the maximum number of residences under applicable zoning and subdivision regulations. Conservation development may be called Conservation Open Space, Cluster Development, Open Space, or Planned Residential Districts. Conservation development allows the same number of homes to be constructed on a piece of property during development while protecting at least 40% of the property as open space. The open space may serve as a buffer between uses of property, helping protect vegetation, streams, wetlands, floodplains, agricultural or historic resources, and manage stormwater through non-structural practices. Conservation development can also apply to commercial and institutional development to create a campus-like layout where buildings and parking can be rearranged to accommodate natural, agricultural, cultural, or scenic resources. Office parks, graduated living facilities, and educational campuses may all be appropriate for a conservation development layout.

Much of the Chagrin watershed is planned to develop at a low density residential use of 2-5 acres per residential lot. While the development of areas at a low density may allow for preservation of rural character and natural resources, it often does not. The use of conservation development can provide another tool to develop portions of the property while maintaining an overall low density. Many

communities in the Chagrin watershed could consider adoption of a conservation development zoning code or flexible site development through overlay districts to protect the valuable resources while still allowing property owners to realize the development potential of a property. By the end of 2013, 8 CRWP Member communities, representing 25% of the watershed, have adopted regulations allowing alternative site design. Several additional communities have similar codes that allow 25-33% open space in conservation developments. As communities consider CRWP's model code, they must determine how large a parcel should be to allow the use of conservation development code, required amount of open space, availability of sewer and water infrastructure, and means to permanently protect open space within the development.

10.14.3 Riparian and Wetland Setbacks

Riparian and wetland setbacks are designed to establish distances from these resources where building and other soil disturbing activities are prohibited unless the applicant obtains a variance from the local community. CRWP's model riparian setbacks recommend setbacks measured on all watercourses, including ephemeral streams. The riparian setback distances are measured from the ordinary high water mark of a stream. Setback widths vary from 25 to 120 feet from either side of the stream and are extended to the 100 year FEMA floodplain and to the edge of any wetlands in the riparian corridor. Wetland setback distances are measured from the delineated edge of the wetlands. Recommended wetlands setbacks are determined by the category of wetland, as determined by Ohio EPA's wetland assessment methods. CRWP recommends a minimum 75 or 120 foot setback from category 2 and 3 wetlands, respectively. CRWP maintains the model ordinance for local municipalities and CRWP worked with Geauga County Planning Commission on the model resolution for Townships. The ordinance version has separate models for riparian and wetland setbacks while the resolution has the setbacks combined with wetland setbacks on riparian wetlands only with recommended setbacks of 30 and 50 feet from category 2 and 3 wetlands, respectively.

Over 80 communities in Ohio have adopted riparian and wetland setbacks, including 15 CRWP Member communities detailed below. In addition to the communities detailed below, the Lake County subdivision code adopted riparian setbacks into new subdivisions in unincorporated areas as of December 17, 2002.
Auburn Township Riparian Setback: Adopted the Geauga County model riparian setbacks in Article 3.06 of the Auburn Township zoning resolution in April 2005 with the assistance of CRWP and the Geauga County Planning Commission.

- **City of Aurora** Riparian and Wetland Setbacks: Adopted the CRWP model riparian and wetland setbacks in March 2001.
- **Bainbridge Township** Riparian Setback: Adopted the CRWP model riparian setbacks in February 2004.
- **Village of Bentleyville** Riparian Setback: Adopted riparian setbacks in October 2007 with minimum setback widths. This code was amended in November 2009 to incorporate CRWP recommended setbacks widths of 25, 75, and 120 feet.
- **Village of Chagrin Falls** Riparian Setback: Adopted riparian setbacks along main streams in April 2002 that requires a minimum 120 foot setback from watercourses with a "…mean surface width at normal low water at least 10 feet…". Setback may be extended to include steep slopes, wetlands, floodplains, and forested areas.
- **Village of Hunting Valley** Riparian Setback: Adopted riparian setbacks along selected streams in October 2001. This local ordinance requires a minimum 300 foot setback from either side of Chagrin River and a minimum 75 foot setback on either side of the larger tributaries in the Village including Griswold Creek, Pepper Luce Creek and several unnamed tributaries. In 2008, Hunting Valley added 25 foot setbacks on headwater streams to this regulation.
- **City of Kirtland** Riparian Setback: Adopted CRWP model for riparian setbacks in June 2002.
- **Mayfield Village** Riparian Setback: Adopted CRWP model for riparian setbacks in August 2013.

- **Village of Moreland Hills** Riparian Setback: Adopted CRWP model for riparian setbacks without expansion to 100 year floodplain and riparian wetlands in October 2006.
- **Orange Village** Riparian Setbacks: Adopted CRWP model for riparian setbacks in March 2006.
- **City of Pepper Pike**: Adopted CRWP model for riparian setbacks in May 2008.
- **Russell Township** Riparian Setback: Russell Township adopted a minimum riparian setback of a 30 foot setback from all watercourses flowing on average of 6 months of the year in November 1967. This resolution was modified in 2009 to follow Geauga County Planning Commission (GCPC) model resolution.
- **Waite Hill Village** Riparian Ecologically Sensitive Areas: In June 1995, Waite Hill Village adopted an Ecologically Sensitive Areas Map into their zoning regulations. This map designated areas such as streams, wetlands, floodplains, and steep slopes as ecologically sensitive. A permit is required prior to disturbing, building on, grading, clear cutting, or developing property in an ecologically sensitive area as designated on the Ecologically Sensitive Areas Map.
- **City of Willoughby Hills** Protected Areas: Adopted in June 2008, this regulation modified the City's existing Hillside regulation to include CRWP model riparian and wetland setbacks widths with setback from designated hillsides.
- **Village of Woodmere** Riparian Setback: Adopted CRWP model for riparian setbacks in February 2004. Woodmere only has a few streams with a small drainage area, thus the riparian setback ordinance details a minimum 25 foot setback from all watercourses.

10.15 Impoundments and Dams

Numerous impoundments and dams exist within the Chagrin River watershed. Most of the dams in the State of Ohio were constructed for recreational purposes. Although numerous dams in the Chagrin River watershed were originally used for mills, water supply or other industrial uses, they are now used for recreational purposes or maintained as historic structures. These structures disrupt the natural flow of water and often cause erosion downstream. In addition if these structures are not properly maintained, they may fail and cause problems ranging from flooding, loss of property, injury or death, release of accumulated sediment. Several dam breaches that have resulted in downstream transport of accumulated sediment include Ivex Upper Dam, Silver Creek Dam, Daniels Park, Hess Lake, and Gates Mills dams. These breaches have caused localized sedimentation and stream instability problems.

Ohio Department of Natural Resources regulates dams in Ohio. They classify dams into four classes.

- **Class I dams** are those that have a total storage volume greater than 5,000 acre-feet or a height of greater than 60 feet. Failure of a Class I dam would likely result in loss of human life or structural collapse of at least one residence or commercial/industrial structure. Class I dams must be designed for the probable maximum flood flood. Class I dams require a permit from ODNR, operation, maintenance, and inspection programs and emergency management programs with flood inundation maps.
- **Class II dams** have total storage volume greater than 500 acre-feet or a height of greater than 40 feet. Failure of a Class II dam would result in one of the following conditions:
  1. Disruption of a public water supply or wastewater treatment facility, release of health hazardous industrial or commercial waste, or other health hazards.
  2. Flooding of high-value property, including but flooding of residential, commercial, industrial, publicly owned, and/or valuable agricultural structures, structural damage to downstream class I, II or III dams, dikes or levees, or other dams, dikes or levees of high value.
  3. Damage or destruction to major roads, railroads, or public utilities, and roads which provide the only access to residential or other critical areas such as hospitals or correctional facilities.

  Class II dams must be designed for 50% of the probable maximum flood or the critical flood. Class II dams require a permit from ODNR, operation, maintenance, and inspection programs and emergency management programs.

- **Class III dams** are those with a height of greater than 25 feet or total storage volume of greater than 50 acre-feet. Failure of a Class III dam would result in at least one of the following:
  1. Property losses including but not limited to rural buildings not otherwise listed as high-value property, and Class IV dams, dikes and levees not otherwise listed as high-value property.
  2. Local roads including but not limited to roads not otherwise listed as major roads above.

  Class III dams must be designed for 25% of the probable maximum flood or the critical flood. Class III dams require a permit from ODNR, operation, maintenance, and inspection programs and emergency management programs.
- **Class IV dams** are those with less than 25 in height and have a total storage volume of <50 acre-feet. Failure of a Class IV dam would result in property losses restricted mainly to the dam and rural lands, and no loss of human life or hazard to health is envisioned. Class IV dams are not required to obtain a permit.

According to ODNR there are eighty-two (82) existing dams in the Chagrin watershed. Of these dams 6 are classified as Class I dams, 9 Class II dams, 10 Class III dams, 16 Class IV dams. The remaining dams in the Chagrin watershed are exempt, abandoned, or unclassified. The names and status of each classified dam are detailed in Table 24. All dams in the watershed should be evaluated and prioritized for removal. CRWP has obtained dam safety inspection reports for the Class I dams in the Chagrin watershed.

Table 24: Class I, II, and III Dams in the Chagrin River Watershed

Dam Name	Dam Class	Inspection Date	EAP Status	OM&I Status	Comments
Shadow Hill Lake	I				No Information Available - have not yet obtained the inspection report from ODNR.
Briar Hill Lake	I	March 30, 2001	None	None	**1992** - Repairs to principal outlet. **2001 -** Report requires owner to perform H&H Study, repair and replacement culvert and inlet wing walls, plans for emergency spillway, lake drain installation, and repairs to upstream slope.
Ivex Corporation Lower Lake	I	April 26, 2005	Yes	Yes	**1994** - Upper dam failed and silted in lower lake – lake drain has not worked since 1994. **1996** – Injection grouting on right embankment to stop seepage. **1999**-1 foot tall concrete wall constructed on right embankment to protect plant. **2001**-grouting of right embankment and abutment to stop seepage. **2005** report indicates H&H study indicates dam will not safely pass the required design flood, lake drain must be cleared, brush removal, monitor scour holes and seepage. **1991** study indicated design flood would cause dam to fail, modification plans for dam were approved by ODNR, but not constructed. **2013:** Modification of dam completed by December 2012and dam declassified.
Lake-In-The-Woods	I	April 26, 2005	Yes, Old	Yes, Old	**2005** report requires owner to update EAP with flood inundation maps, update OM&I, remove trees from dam and reseed, repair footpath near principal spillway inlet, remove debris from principal inlet.
Lake Lucerne	I	April 26, 2005	None	None	**2005** report requires owner to perform H&H study to determine if dam will pass the required design flood, investigate emergency spillway adequacy, prepare EAP and OM&I, stump/brush removal, reseed bare areas, replenish

Dam Name	Dam Class	Inspection Date	EAP Status	OM&I Status	Comments
					rip rap on upstream slope at ends of dam, monitor for seepage.
Tanglewood Lake	I	June 4, 2004	None	None	**1981** principal spillway partially failed. **1994**–several feet of water flowed through emergency spillway. **2001**-add 2 sluice gates inside principal spillway riser. **2003** – Widen emergency spillway, raise crest of dam. **2004** report requires owner to prepare EAP and OM&I, remove brush from dam, remove debris from principal spillway, reapply joint sealant between the concrete and corrugated metals portions of outlet pipe, monitor seepage and erosion gully at toe of dam. **2011** Dam was dredged in February to remove accumulated sediments.
Fowler's Mill Golf Course Upground	II				Fowler's Mill Golf #164
Luczek Lake Dam	II				Stephen F. Luczek, M.D.
University School Lake Dam	II				University School
Kenston Lake Dam	II				Removed and stream restored in November 2011 with a 319 grant obtained by Bainbridge Township.
Hidden Lakes Dam	II				Hidden Lakes Limited Part.
Bellwood Lake Dam	II				Bellwood Club Inc
Paw Paw Lake Dam	II				Paw Paw Lake Home Company
Lake Louise Dam	II				Lake Louise Property Owners Assn.
Roundup Lake Dam	II				Being maintained by Roundup Lake Park, Inc.
Grootegoed Lake Dam	III				Robert G. & Wilma A. Grootegoed
Levine Lake Dam	III				James R. Levine
Deer Lake Estates Dam	III				HOA is monitoring and maintaining with advice from consulting engineer.
O'Neil Lake Dam	III				O'Neil Lake Association
Frohring Lake Dam	III				Evelyn R. Frohring
Plzak Lake Dam	III				Don Plzak, Doris Gilbert,
Bainbridge Quarry Lake Dam	III				Stoneridge Land Company
Bear Town Lake Dam	III				Geauga County Park District is maintaining.

Dam Name	Dam Class	Inspection Date	EAP Status	OM&I Status	Comments
Sunny Lake Dam	III				City of Aurora is maintaining. Work completed on dam in 2006.
Walter C. Best Lake Dam	III				Geauga Park District is maintaining.

11 Physical Attributes and Water Quality of Watershed

Numerous studies have been completed on the water quality of the Chagrin River. The first of these reports is the 1970 report from the Three Watershed District. Although this study indicated that water quality in the Chagrin was relatively good, several problems in the Chagrin watershed were noted including eutrophication of small lakes, siltation due to stream bank erosion and gravel operations on the East Branch, soil erosion, septic tank overflows, open dumping of rubbish and debris, marinas near the mouth of the Chagrin, and wastewater treatment plant inputs (Havens and Emerson). Many of these issues are still of concern. Improvements in water quality and stormwater management have been made, but additional development int the watershed continues to threaten the health of the Chagrin River.

Ohio EPA 303(d) list of impaired streams is organized on the basis of 10 digit HUC. In the Chagrin, two 10 digit HUCs are delineated as detailed in Section 6.4. However this plan is organized by the seven 12 digit HUC watersheds, therefore numerous areas of the Chagrin are designated as impaired in the 303(d) list, but the individual stream segments are in full attainment of their designated uses. Information is presented below from various Ohio EPA reports, observations of CRWP staff, and data from stakeholders of this *Plan,* and independent water quality reports and studies. Attached appendices illustrate the *Chagrin River Watershed Balanced Growth Plan*, subwatersheds referenced in each section below, aquatic life use, and attainment status.

11.1 Lower Chagrin: Town of Willoughby-Chagrin River: 04110003-04-03

The Lower Chagrin is represented by 12 digit HUC 04110003-04-03 and includes the main stem of the Chagrin River below the confluence with the East Branch downstream to Lake Erie. The 305(b) and 303(d) report identifies causes of impairment in this segment as unknown, organic enrichment, flow alteration, and other habitat modifications. Sources are identified as major municipal point sources, marinas, urban runoff/storm sewers, land development/suburbanization, and unknown sources. Problems stem from alteration of habitat from marina construction, dredging, riparian vegetation removal, channelization, development in the 100-year floodplain and the upstream effects of changing land use with associated increased urban stormwater runoff. The 2003-2004 Chagrin River Water Quality Study from Ohio EPA indicates that sampled main channel stream segments along this reach are in full attainment of their aquatic life uses.

11.1.1 Chagrin River Main Stem (mouth to RM 4.6)

The mouth of the Chagrin River was changed to its present location by the US Army Corps of Engineers circa 1930. As seen in Figure 22 the original mouth of the river was situated to the east of the existing mouth. During high stream flows the City of Eastlake typically uses a backhoe to open up a channel through the sand bar that forms over the former mouth.

Several islands are present near the mouth of the Chagrin. Two of these, Anchor and North Islands remain undeveloped. As of December 2009, Anchor Island was purchased by the Eastlake Port Authority that will work with Lake Metroparks to preserve it as permanent open space. North Island has 36 parcels with approximately 23 property owners that own parcels on this island. The Eastlake Port Authority and Lake Metroparks continue to work on preservation of the parcels on North Island. As of 2013 several

were donated or purchased by Lake Metroparks. Around these islands and in various other channels, numerous marinas with docks provide recreational boating opportunities. The need for dredging the recreation channel at the mouth and the back channels through the marinas is symptomatic of sedimentation problems from upstream sediment loadings and river mouth characteristics. At the mouth, water slows down and sediment settles out in the mouth of the Chagrin River as it enters Lake Erie. Although the need for continuing dredging activities will continue, activities upstream to minimize sediment entering the stream will assist to minimize dredging concerns. The Eastlake Port Authority has the task of annually dredging the mouth of the river to maintain recreational boating accessibility.

Figure 22: Mouth of Chagrin River

The mouth of the Chagrin River also has a wide 100-year floodplain delineated. In addition nearly all os the channel from Lakeshore Blvd. north is armored with steel sheet piling along both banks. Directly south of the Lakeshore Blvd. crossing on the left bank of the river is Boracs Landing. This property has been explored for several development scenarios. The next 3.8 miles of the Chagrin River are either constricted by levees, entrenchment, or natural constrictions due to high shale cliffs. Just downstream of the confluence with the East Branch of the Chagrin, at river mile 4.6, are remnants of a low head dam at Daniels Park. This dam was created around 1920 to impound water for the City of Willoughby municipal water supply. The impoundment has not been used as a water supply source since the 1970's. The dam had eroded a dangerous plunge pool directly downstream of the dam and several people have been injured or drowned here. Over New Year's weekend 2005, the dam breached and fell over into its own plunge pool. In 2000, students at Case Western Reserve University had completed a study and estimated that approximately 24,000 cubic yards of sediment were trapped behind the dam. Although this raised concerns about sedimentation near the mouth it is likely that much of this sediment was washed downstream as the river was flowing at approximately 20,000 cubic feet per second at the time of the breach. As of 2013, the area surrounding the dam has not been restored and the remnants of the dam remain in the location that they fell.

In 2008, the US Fish and Wildlife Service began studying options for creating a low barrier for sea lamprey near the location of the old Daniels Park dam. The U.S. Fish and Wildlife Service (FWS) completed modeling in 2009 on the historic Daniels Park Dam to determine if the dam acted as an effective sea lamprey barrier. FWS determined that the dam did not act as a sea lamprey barrier in the past as it overtopped during 5-10 year storm events which happen frequently. Thus far, sampling has indicated that the Chagrin River does not have a sea lamprey population, and the FWS will not pursue the construction of a sea lamprey barrier at this time. FWS also noted that the Kirtland Country Club dam is not an effective lamprey barrier, however Ohio EPA staff still felt this was an important structure to maintain as the East Branch of the Chagrin has good habitat for the invasive lamprey. FWS will continue sampling in the Chagrin River and East Branch to determine if sea lamprey populations are found. To

date, one larval sea lamprey was captured in the Chagrin and East Branch. Factors other than the dam itself may have played a part in blocking sea lampreys in the Chagrin River including temperature, water velocity, and lack of suitable larval habitat.

In 1987, Ohio EPA indicated a moderate enrichment at river mile 4.2 with a predominance of blackflies and hydropsychid caddisflies and an ICI of 42, which was lower than upstream ICI scores. From 1978 – 1987 the Chagrin River from the Aurora Branch to River mile 4.2 was designated as Exceptional Warmwater Habitat. The 1986 survey indicated this use designation should be changed to WWH. The 1995 Chagrin River Water Quality Study noted increased phosphorus concentrations from stormwater runoff and WWTP effluent. The lower main branch of the Chagrin River is in full attainment of its WWH use designation in the 2003-2004 sampling. Unique species found in this area included a Bigeye Chub near the mouth.

11.1.2 Corporation Creek (RM 0.27)

Corporation Creek is the first tributary to the Chagrin River upstream of Lake Erie and drains approximately 5.3 square miles. Corporation Creek forms a westerly loop channel in the river thus is sometimes referred to as the West Branch of the Chagrin River. Near the mouth this tributary provides an access point for recreational boating at the Eastlake Port Authority boat ramp. The headwaters of this stream exhibit highly urbanized watershed characteristics including a large retention basin owned by the City of Willoughby north of the intersection of State Route 2 and Vine Street. The stream flows through several residential subdivisions before crossing under Erie Road and reaching a property protected by the City of Eastlake known as the Syracuse Property. Historically the culvert under Erie road has caused overtopping of the road due to lack of stormwater management, past development, floodplain removal and clogging of the culvert with woody debris. Downstream of the Syracuse Property the stream is a low gradient stream with a sandy substrate and flowing north through open property owned by Cleveland Electric Illuminating Company (CEI) before flowing into the Chagrin River. At the confluence of the Chagrin River and Corporation Creek is a small island with numerous residences. These homes on West Island Drive are prone to flooding and occasionally have to be evacuated because of safety concerns. In 2008, Ohio EPA designated this stream as WWH and Seasonal Salmonid Habitat (SSH) use.

11.1.3 Ward/Newell Creek (RM 1.0)

Ward/Newell Creek enters the main channel one mile upstream of Lake Erie. In Mentor, the creek is referred to as Newell Creek, while it is called Ward Creek in Eastlake and Willoughby. The creek drains 7.8 square miles of commercial, industrial, and higher density residential development. Approximately 28% of this area is covered by a hard surface such as roads, buildings, or parking lots (Figure 23) making Ward/Newell Creek the most impervious subwatershed in the Chagrin. Research shows that small urban streams with greater than 15% impervious cover have a low probability of meeting water quality standards and those exceeding 25% imperviousness are not at all likely to attain standards. Due to the age of the development in this area, much of this impervious cover does not have stormwater management.

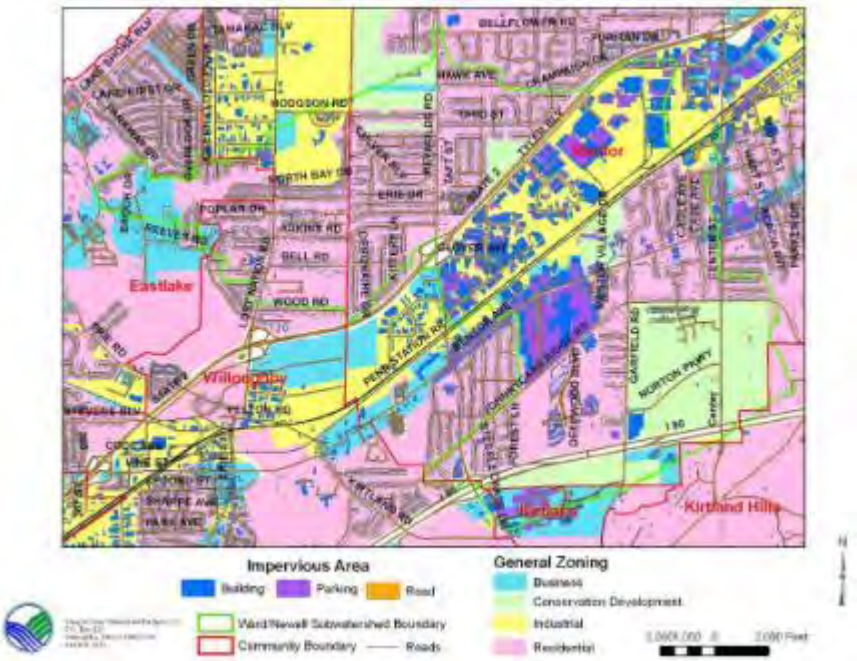


Figure 23: Land Cover in Ward/Newell Creek

Approximately 5% (245 acres) of the subwatershed is open space as park land or vacant municipal property as shown in Figure 24. The lower corridor of this stream in Willoughby runs through the Lost Nation Golf Course and is a greenspace corridor in Eastlake with land management agreement with Lake Metroparks; however this section still does not meet Ohio EPA standards largely due to the stormwater discharges and habitat modifications.

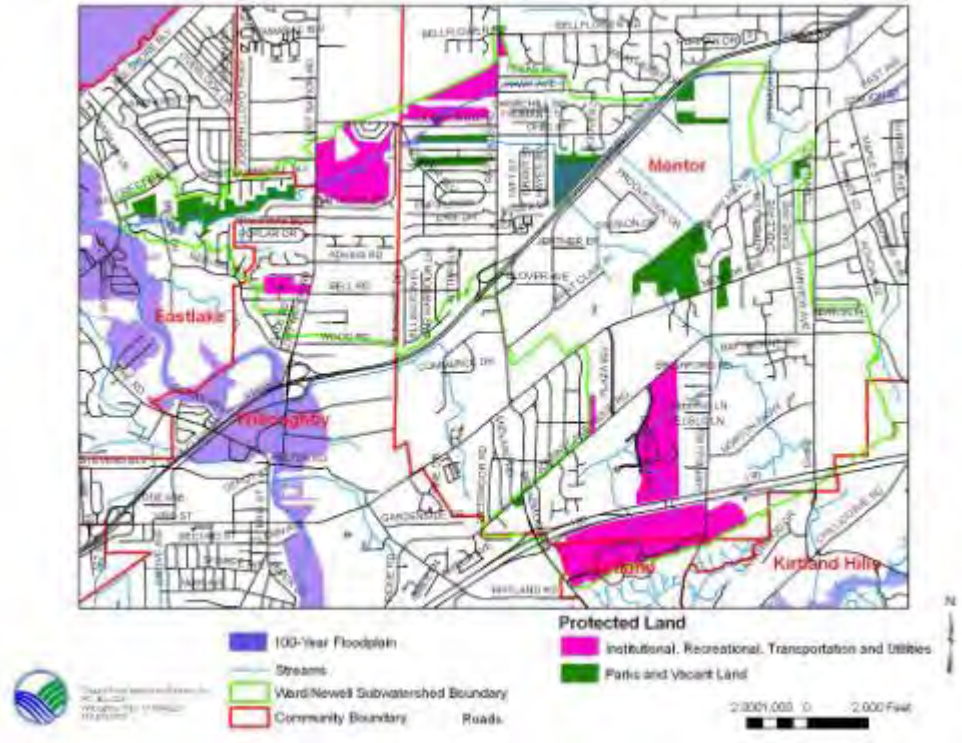


Figure 24: Protected Land in Ward/Newell Creek

The Cities of Eastlake, Willoughby, and Mentor all participated in the Chagrin River Watershed Balanced Growth Plan and identified and endorsed priority conservation areas (PCAs) and priority development areas (PDAs) as shown in Figure 25. Within the Ward/Newell subwatershed the PDAs include commercial and industrial zoned property where development already exists or redevelopment may occur, as well as future development in the Newell Creek development off Norton Parkway in the southeast portion of the subwatershed. PCAs include riparian corridors, existing parks, Lost Nation Golf Course, conservation easements, open space in the Newell Creek Development, and large parcels that may be possible open space or conservation easements.

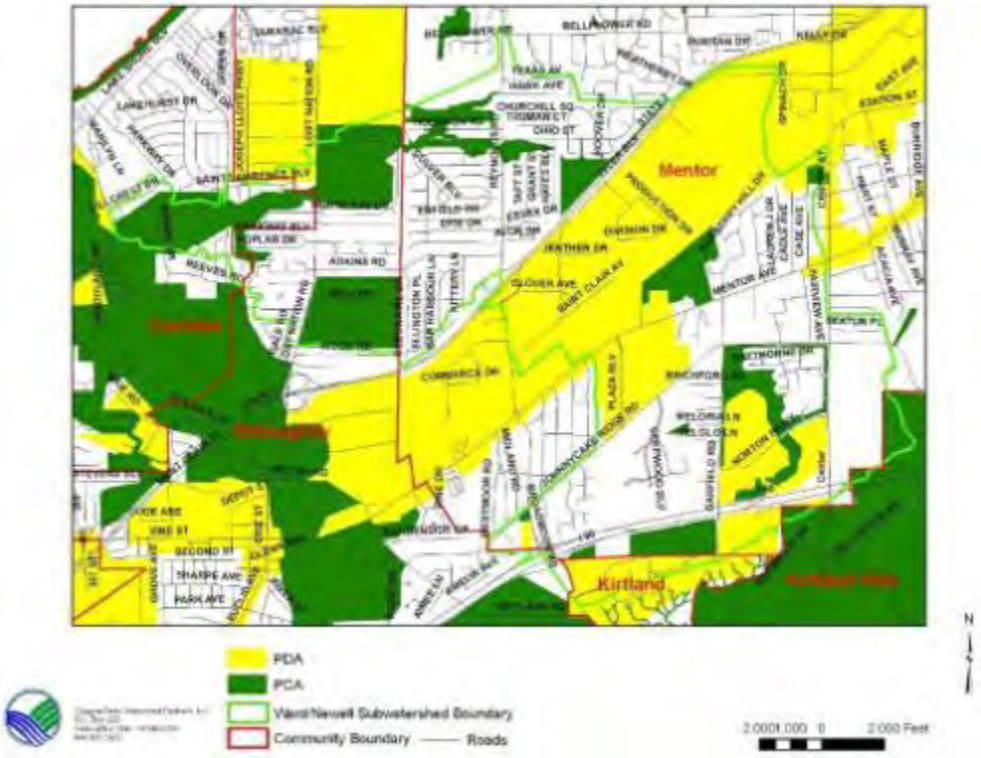


Figure 25: PCAs and PDAs in Ward/Newell Creek

Ward/Newell Creek is designated as a Warmwater Habitat (WWH) stream. Based on 2003-2004 Ohio EPA sampling, Ward/Newell Creek in Eastlake at RM 0.80 near the Robin Road pump station is in non attainment of the WWH aquatic life use due to sedimentation and erosion from flow alteration and nutrient inputs and organic enrichment from suburban/urban runoff and storm sewers. Ohio EPA also noted excessive stormwater effects, such as down-cutting, bank erosion, and sedimentation. No significant WWTPs discharge to Ward/Newell Creek; however, urban runoff is extensive and includes residential and commercial sources as well as a golf course and airport. Ohio EPA noted that: "Excessive water energy from impervious area runoff, siltation and loss of riparian habitat are likely stressors on biology given the urban nature of the watershed, and should be the focus of future water quality studies."

Fish communities in Ward/Newell Creek were rated as Fair and are impaired by hydrologic alteration, sedimentation, and toxicity from urbanization. The Ward/Newell Creek macroinvertebrate community quality is affected by an upstream WWTP and diffuse NPS inputs. Relative organism density was high and attributed to nutrient enrichment and increased primary production. High relative densities of caddisflies, filtering midges, and facultative mayflies were predominant in the riffle/run habitats. While sampling, solids and algal mats were observed in the slower runs and margins, and much less diverse and more tolerant biota were collected laterally from the more oxygenated thalweg (center of the main flow channel). The stream color was murky grey to green. Fair macroinvertebrate community quality was

documented with 25 total taxa and only four EPT and sensitive taxa collected. Better wastewater treatment, stormwater runoff controls, and improved riparian corridor thickness and canopy cover would improve the biological community quality. The QHEI score meets the WWH criteria for this stream.

The following details the condition of Newell/Ward Creek and opportunities for retrofits and restoration. In 2013, CRWP received a Great Lakes Restoration Initiative (GLRI) grant to complete stormwater retrofits at Great Lakes Mall, restore Ward Creek through the Lost Nation Golf Course and subsidize implementation of stormwater control measure on the 5,000 residential parcels in this subwatershed.

Figure 26: Channelized Stream

In the southwest corner of the watershed a branch of Ward/Newell Creek flows through existing development with limited stormwater management to a 73 acre parcel of land, noted for future development. This parcel has significant frontage on Johnnycake Ridge Road just west of Deepwood Boulevard and is zoned for residential development. It is critical that the stream corridor be protected during the site design of this development and that effective stormwater control measures are installed as this area develops.

The stream flows east towards Deepwood Boulevard where approximately 880 linear feet of stream has been piped from Deepwood Boulevard to the east. The property is owned by Lake County and may provide opportunities for daylighting the Deepwood Boulevard stream in the future. The velocity of flow through this culvert appeared to create a channelized stream downstream of this area on the property owned by the City of Mentor south of Ridge Middle School. Although this stream has a wooded riparian corridor, the stream is channelized with no accessible floodplain, as seen in the adjacent photo and Figure 29. Residents downstream on Stonybrook Drive have frequent flooding concerns immediately downstream of this proposed restoration area. This stream restoration would create additional floodplain storage volume to detain and slow the flow of stormwater. To immediately address concerns of the Stoneybrook residents, Mentor replaced the twin culverts under Stoneybrook drive with a larger box culvert to minimize the higher stream flows backing up at this point.

In the southeast corner of the watershed, the main channel of Ward/Newell Creek flows through the Newell Creek Development. This development is a mixed use development including office, residential, recreational, and open space that has not been built out to its planned capacity. A regional stormwater pond was constructed to manage the stormwater from much of this development. As the development plans are finalized, the City of Mentor should ensure that the regional basin will provide adequate stormwater management. In addition, a future Chagrin River stormwater permit may require additional infiltration practices for the water quality volume. The developed residential areas on the southern portion of the site drain to the upper basin in the northwest corner of the development. This basin treats the stormwater and discharges to the lower basin which ultimately drains across the intersection of Johnnycake Ridge Road and Garfield Road into Ward/Newell Creek.

The tributary that drains the Deepwood Boulevard and Ridge Middle School area also drains onto the Newell Creek development site at the northwest corner of the site. This tributary flows along the lower basin described above, but at higher stream flows is allowed to overflow into this pond. The overflow is facilitated by placing a steel plate over a portion of the box culvert under Garfield Road so that when the stream reaches a certain level it backs up into the Newell Creek Development lower basin.

Great Lakes Mall is located north of Johnnycake Ridge Road and south of Mentor Avenue. The stormwater management for this site currently consists of a drainage network with no detention or infiltration facilities. In 2013 CRWP received a Great Lakes Restoration Initiative grant to retrofit portions of the mall parking lot with porous pavement and bioretention. Construction is slated for summer 2014. As the Great Lakes Mall constitutes a large contiguous area of impervious cover, it is the highest priority for stormwater retrofit and green infrastructure for both CRWP and the City of Mentor. CRWP will continue to work with parties on modeling and potential funding for additional retrofits at the mall and along the Mentor Avenue corridor.

Figure 27: Great Lakes Mall

Downstream of the mall, a group of apartment buildings experience regular flooding in their parking areas. The parking is located directly next to the stream at a very similar elevation. CRWP and the City of Mentor have discussed several opportunities to create an additional floodplain storage area to slow the flow down before it reaches the Garfield Park Pond.

Garfield Park Pond is located downstream of the mall and has the highest potential for retrofit opportunities because it is within a City-owned park. Dredging accumulated sediment from this pond could reclaim some of its original storage volume. Further, modifying the outlet structure by both lowering the principal outlet structure and adding an additional outlet structure at a higher elevation would provide additional storage during storm events flow with a gradual outflow of this additional storage volume.

Figure 28: Garfield Park Pond

Figure 29: Outlet Structure at Garfield Park Pond

Figure 30: Horvitz Pond Improvements

Another potential area for stream restoration is located east of Jenther Drive, off of Tyler Boulevard and west of Production Drive. Ward/Newell Creek is channelized through this industrial/commercial area. CRWP is currently discussing with the City of Mentor the possibility of creating additional floodplain storage along this corridor if the City of Mentor has a stormwater easement on this stream and the surrounding corridor. Ultimately all of the areas described above drain to Horvitz Pond. According to the City of Mentor, Horvitz Pond was retrofitted in 1988 to provide more flood volume while not allowing the system to surcharge and back up into neighboring subdivisions as was its historic nature. The retrofit provided storage up to the 25-year storm and releases the flow at a 5-year rate. Since this retrofit was completed, the system has been working efficiently to reduce localized flooding, however this retrofit was not designed to improve water quality.

The portion of stream that flows behind the homes on Hodgson Road is currently in a pipe with an overflow concrete channel above it, shown below. The Hodgson Road stream could be daylighted to restore a natural stream channel with riparian vegetation. After having discussions with Mentor, it

appears that the residents along this portion of stream and downstream of it have not had complaints so this will not be one of the highest priority restoration sites. In addition, CRWP does not recommend completing this work until additional stormwater storage has been created upstream.

Figure 31: Concrete Channel along Hodgson Road

Figure 32: Concrete Channel along Hodgson Road

The lowest reaches of Ward/Newell Creek flow through the Lost Nation Golf Course, owned by the City of of Willoughby as shown in

Figure 33. CRWP and the City of Willoughby completed a stream restoration project in late 2013 to reconnect floodplain areas and add more natural vegetation through the golf course. This project is part of the larger GLRI project that includes the Great Lakes Mall retrofits and subsidized stormwater BMPs for Newell/Ward Creek residents.

Figure 33: Restoration at Lost Nation Golf Course

11.1.4 Summary and Recommendations

The Lower Main Branch of the Chagrin and tributaries are the most densely developed areas of the Chagrin River watershed. This presents both challenges and opportunities for restoration of streams, wetlands and floodplain, protection and management of existing open space, and retrofits to incorporate stormwater management. In addition the observed problems in this subwatershed highlight the importance of good local land use planning, and consistent implementation of local ordinances, such as floodplain regulations, erosion and sediment control, stormwater management, and riparian setback.

The Cities of Mentor, Willoughby and Eastlake have adopted CRWP model codes for:

- Erosion and Sediment Control
- Comprehensive Stormwater Management
- Illicit Discharge and Detection
- Flood Damage Reduction regulations
- Off Street Parking (Mentor only)

CRWP also recommends the adoption of these additional development regulations:

- Riparian and Wetland Setbacks
- Conservation Development
- Parking Regulations that decrease unused impervious surface (Eastlake and Willoughby)

Future recommendations include restoration of floodplain connectivity, improved stormwater management for new development and retrofits of existing stormwater management, revegetation of riparian corridors, and protection of additional open space. CRWP developed specific locations for potential stormwater retrofits, protection, and restoration projects within the Ward/Newell Creek corridor as shown in Figure 34 below. The potential restoration and retrofit opportunities are detailed below followed by a discussion on specific projects and opportunities.

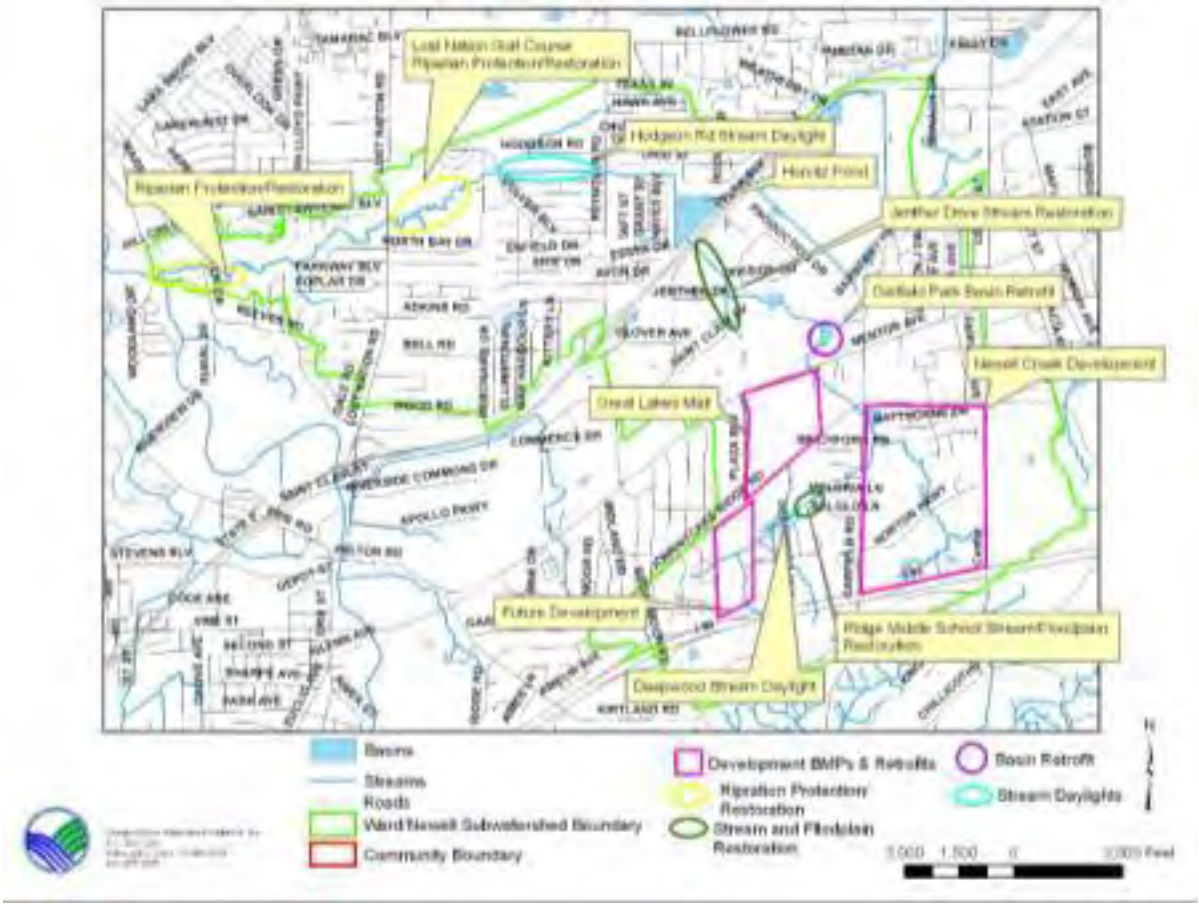


Figure 34: Recommendations for Ward/Newell Creek

Opportunities to retrofit existing development with stormwater management should be considered wherever possible throughout this watershed. Specifically additional retrofits at Great Lakes Mall and other developments along Mentor Avenue should be encouraged due to the possibility of infiltrating significant stormwater in sandy beach ridge soils.

Many of the streams in this subwatershed have been impacted by channelization and stormwater inputs that have caused entrenched streams with little floodplain access. Possible stream restorations include:

- Excavate an appropriate floodplain width at an elevation accessible to the stream on the property owned by the City of Mentor south of Ridge Middle School.
- Daylight the Newell/Ward Creek at downstream of Deepwood Boulevard.
- Create additional floodplain storage along stream by Jenther Drive.
- Daylight Newell Creek upstream of Hodgson Road stream with a natural stream channel with riparian vegetation.

Several inline ponds exist through the Newell Creek corridor in Mentor, CRWP will continue to work with Mentor to explore possible retrofit opportunities to improve flood control and water quality benefits of these ponds including Horvitz Pond at President's Park and Garfield Park Pond.
The City of Eastlake and Lake Metroparks have protected a significant length of Ward/Newell Creek from Lost Nation Boulevard to the mouth. CRWP recommends that additional easements or land purchase be acquired to extend this protected area to the mouth of Ward/Newell Creek. Figure 35 highlights the potential properties for additional protection.

Figure 35: Potential Properties for Additional Protection, Ward/Newell Creek

In addition to water quality concerns, consistent application of local floodplain regulations will assist to ensure the safety of residents in the 100 year floodplain. Given the importance of recreational boating to the area's economy, the channel mouth will continue to be dredged, resulting in ongoing alteration of river mouth habitat. Upstream activities to minimize sedimentation will also assist to minimize the necessity of dredging. CRWP will also continue to work with the Lake County Planning Commission, City of Eastlake and the Eastlake Port Authority to develop and encourage recreational boating activities and associated development while making allowances for water quantity and quality concerns.

11.2 East Branch Chagrin River: 04110003-04-01

The East Branch of the Chagrin is represented by 12 digit HUC 04110003-04-01 and encompasses the East Branch Chagrin River and all of its tributaries. The East Branch drains 51 square miles and joins the Chagrin River at river mile 4.98. The 305(b) and 303(d) report identifies causes of impairment in this segment as unknown, organic enrichment, flow alteration, and other habitat modifications. Sources are identified as major municipal point sources, marinas, urban runoff/storm sewers, land development/suburbanization, and unknown sources. In addition, failing home sewage treatment systems and stream bank erosion can be seen as sources of impairment.

The East Branch is the least developed of the Chagrin 12 digit HUC watersheds. It is experiencing development pressures in the upper reaches of the watershed and encroachment on headwater streams. This has resulted in riparian vegetation removal. Stream bank erosion is a major problem in the watershed due to highly erodible soils and steep stream gradients. Subsequently, the East Branch is very sensitive to any changes in stream hydrology that may be caused changes in runoff, climatic changes, and

changes in land use. The other major problem is septic tank leachate or off lot discharges of septic tanks. Malfunctioning septic tanks are causing high levels of fecal coliforms based on Ohio EPA studies (1991).

The East Branch and all of its tributaries are currently designated as coldwater habitat (CWH). As development continues, the CWH status of this stream is becoming threatened. In the 2003/2004 sampling seasons a comprehensive sampling effort was completed on the East Branch and numerous tributaries. This sampling effort added an EWH aquatic life use to make a dual designation of CWH/EWH for several streams.

11.2.1 Main Stem East Branch

The 1987 Ohio EPA Water Quality Study indicated that macroinvertebrate communities in the East Branch of the Chagrin River were considered to be good to exceptional. The 1990 Ohio EPA water Quality Study for the Chagrin concluded that the East Branch was fully attaining CWH based on a narrative based assessment, but also showed high levels of fecal coliform bacteria. The macroinvertebrate and fish community both exhibited cool/coldwater species and two crayfish species listed as "Special Interest" by ODNR. Steel sheet pile dams at Heath Road (RM 16.3) are an impediment to fish migration and appear to be impacting the CWH character of the stream at this location. Portions of this stream are partially attaining upstream with non-attainment at RM 2.4 as noted in 2003-2004 sampling.

In November 2007, Ohio EPA distributed draft orders to Village of Kirtland Hills and Mr. Jerome Osborne for impacts to the East Branch of the Chagrin River. In Fall of 2013, the Village of Kirtland Hills completed a restoration of this impacted area by restoring riffle pool structures and floodplain access. In addition, the Holden Arboretum removed a levee along 385 linear feet of the East Branch of the Chagrin River, restored 330 linear feet of headwater tributary to the East Branch, and restored 3.5 acres of floodplain forest and riparian corridor at the Riverwood Farm property in Chardon Township, Geauga County near river mile 11.5 with funding from Ohio EPA Section 319 grant funds.

Impacts in the East Branch are due to suburban development, dredge mining, and sediment dams. Sand load, embeddedness, and thermal temperature increases are all related to these habitat and flow alterations. Ohio EPA noted that the upper reaches of the East Branch are still attaining CWH where continuous forested riparian corridors are present, but are declining. The East Branch at Markell Road is in non attainment of CWH. Ohio EPA recommends that special attention in future sampling be given to water temperature and its association with loss of riparian habitat.

11.2.2 Quarry Creek (RM 1.85)

Quarry Creek enters the East Branch at river mile 1.85. Ohio EPA noted a very high Index of Biotic Integrity (IBI), including declining species such as longnose dace (*Rhinicthys cataractae*), for this stream that warrants protection of this stream corridor. Ohio EPA further noted stormwater impacts along this stream. The QHEI score for this stream in 2004 was 55 noting lack of instream cover, shallow pools, and embedded substrates. In 2008, Ohio EPA changed the aquatic life use of Quarry Creek to a dual CWH/EWH uses and noted that the stream is in full attainment of both uses.

11.2.3 Stoney Brook (RM 3.57)

Lake SWCD completed headwater stream sampling along this tributary in 2003 and Ohio EPA sampling from 2003-2004 indicates this stream is in partial attainment of its CWH use. Sources of impairment include removal of riparian vegetation, suburban nonpoint sources, package plants, HSTS, and suburbanization causing in thermal and flow modifications, nutrient loads and habitat alteration. In 2012 sanitary sewers were extended through Kirtland along St. Rt. 306, eliminating effluent discharge from existing package plants. Subsequent sampling of Stoney Brook will determine if these infrastructure improvements improve water quality in this area to fully attain CWH use.

11.2.4 Pierson Creek (RM 6.73)

ODNR introduced Native Ohio Brook Trout into this stream and although Pierson Creek has been reproducing rainbow trout for years, the brook trout are not successfully reproducing in this stream. In 2004, Ohio EPA changed the use of Pierson Creek to a dual CWH/EWH uses and noted that the stream is in full attainment of both uses. Ohio EPA noted a high IBI score of 56 for this stream. River chubs (*Nocomos micropogon)*, a declining species, and longnose dace (*Rhinicthys cataractae*) were both found in this stream. In respect to this creek's physical attributes Ohio EPA found it to have an unusually large bedload of sand and gravel, yet it still has excellent to good habitat. Headwater stream surveys conducted by Lake SWCD showed that of 42 assessed streams, 36% were Class III, 50% were Class II and remaining were Class I. In 2013 the Holden Arboretum received a 319 grant to complete a restoration of a headwater stream to Pierson Creek at the outlet of Heath Pond. The restoration was completed in fall of 2013 with planting proposed for spring of 2014.

11.2.5 Baldwin Creek/Shadybrook

The Holden Arboretum applied for a 319 grant in 2005 to restore the natural stream channel and associated riparian area along Shadybrook, a coldwater stream. The project was constructed in Summer of 2008 and restored 730 linear feet of stream and associated riparian habitat to route the stream around the 1927 dam. Sampling by Ohio EPA in 2011 noted that this stream was fully attaining CWH status. A large storm event in July 2013 destabilized sections of this stream and several slopes upstream and downstream of the restoration area. The lower half of the restored stream section was blown out and appears to be at the original stream bed elevation prior to the dam construction. ODNR introduced Native Ohio Brook Trout into this stream near the confluence with the East Branch. Andy Burt, ODNR Division of Wildlife documented brook trout reproduction in this stream and noted that the stream will require further evaluations. ODNR will not be stocking any additional trout, so it is up to the trout to maintain their populations. CRWP recommends follow sampling to determine if this stream still meets Ohio EPA standards for CWH after the July 2013 storm event.

11.2.6 Mt. Glen Tributary/Unnamed Tributary (RM 10.13)

Ohio EPA considered this unnamed tributary and Stebbins Gulch, below, to be near pristine habitats and in full attainment of CWH use. This high quality CWH tributary is worthy of protection activities. ODNR has stocked brook trout in a small tributary to this stream. It also supports an exceptional fish and cold water macroinvertebrate communities.

11.2.7 Stebbins Gulch (RM 10.6)

Stebbins Gulch enters East Branch at river mile 10.6. Much of this subwatershed is protected by the Holden Arboretum. Stebbins Gulch is a bedrock ravine system with unique geology, microclimate, and vegetation communities. The deep ravine traps cool air and reduces the mean annual temperature, yielding the coldest water of all tributaries, 14.0º C, measured by Ohio EPA on July 8th, 2004. Summer air temperatures rarely rise above 75º Fahrenheit in the ravine. In winter the ravine walls block the wind and moderate the temperatures. Stebbins receives ground water annually and exhibits a high quality CWH biological community. Stebbins Gulch is a restricted natural area and was designated in 1968 by the U.S. Department of the Interior as a Natural History Landmark. Ohio EPA sampling indicates this stream is in full attainment. This has very clean, nearly silt-free substrate composed of glacial till and sandstone helping explain the abundance of young of year steelhead trout. Lake SWCD completed a headwater stream analysis on all of the streams in Stebbins Gulch. Of 43 assessed streams, 39.5% were Class III, 25.5% were Class II and remaining were Class I.

11.2.8 Harris Creek/Unnamed Tributary (RM 14.62)

In 2003/2004 sampling, Ohio EPA noted several problems including removal of riparian vegetation, sedimentation, and habitat alteration via barrier falls at the Heath Road bridge crossing. The observed fish community was marginal and indicated this stream is not currently meeting CWH standards and the stream is in partial attainment. Harris Creek is a biologically diverse cold water tributary with an exceptional macroinvertebrate community including eight cold water taxa, 23 EPT taxa, and 31 sensitive taxa, including two intolerant stonefly taxa. The shaded riparian corridor kept water temperatures lower (~17.5°C. in 9/2006). Riffles and runs were similar upsream and downstream from the Heath Rd. bridge, but a plunge pool was downstream below step waterfalls. It should be noted that this vertical drop from the bridge structure inhibits coldwater fish recolonization and salamander movement to upstream reaches from downstream sources. Removal of the fish barrier to allow fish migration can improve diversity.

11.2.9 Unnamed Tributary (RM 14.80)

Southern redbelly dace were present in this stream, indicating a coldwater stream. However, the sampling area corridor has been altered and the Sperry Road crossing may be impacting the stream, with a silt trap box below the road crossing. Upstream portions of this stream run through Lake Farmpark and the Mayer Preserve. On the Mayer Preserve, August 2000 stream temperature was 19 degrees Celsius. Common (C) and abundant (A) fish species and abundance noted on the Mayer Property included: Stoneroller (A), Blacknose dace (A), Redside dace (C), Red-bellied dace (C), and Creek chub (C). The upper reaches of this stream have been proposed as a park for Chester Township with combined active and passive recreation. The protection of the stream corridor upstream and cool water temperatures noted upstream indicate this may be an excellent candidate for stream restoration in the immediate study reach. Ohio EPA sampling in 2003-2004 indicated partial attainment of CWH use caused by habitat and flow alteration and sedimentation. Modification of the road crossing to allow fish migration could improve attainment status.

11.2.10 Unnamed Tributary (RM 15.35)

Much of this subwatershed is developed as residential, but the riparian corridor appears to be mainly intact. Ohio EPA added the use of EWH to CWH and noted that the stream is in partial attainment of CWH use and full attainment of EWH. Impairments are caused by habitat and flow alteration and sedimentation. Modification of bridge could allow fish migration.

11.2.11 Unnamed Tributary (RM 16.2)

Ohio EPA noted longnose dace, American Lamprey, and rainbow trout in this stream during the 2004 sampling. ODNR has stocked brook trout into this tributary. In April of 2008, Ohio EPA changed the use of this tributary to dual CWH /EWH uses and noted that the stream is in full attainment of both uses.

11.2.12 Summary and Recommendations

Because the East Branch has a steep gradient and naturally erodible soils, sedimentation problems are expected to continue to occur and potentially increase due to development and corresponding increases in impervious cover. Any additional protection on riparian corridors in this area of the watershed is strongly encouraged. Potential projects to maintain the integrity of this subwatershed include: stream restoration projects to restore floodplain access and provide shading, livestock exclusion in upper reaches of the Pierson Creek subwatershed, removal of barriers near Heath Road, and investigation and replacement of failing HSTS. Modifications near road and bridge crossings to improve fish migration would assist in attaining water quality standards. Ohio EPA recommends performing additional biological surveys of tributaries between RM 16.3 and 20.0 to identify streams that serve as potential refugia for cold water fish, macroinvertebrates, and salamanders.

11.3 Main Stem of Chagrin River: Griswold Creek-Chagrin River: 04110003-04-02

The main stem of the Chagrin River is represented by 12 digit HUC 04110003-04-02 and includes the main branch of the Chagrin River below the Aurora Branch to above the East Branch. Subwatersheds included in this segment are Willey Creek, Pepper/Luce Creek, Griswold Creek, Caves Creek, Beecher's Brook, Upper 40/Foster's Run, Gulley Brook, and numerous unnamed tributaries. The 305(b) and 303(d) report identifies causes in this segment as unknown, organic enrichment, flow alteration, and other habitat modifications. Sources are identified as major municipal point sources, marinas, urban runoff/storm sewers, land development/suburbanization, and unknown sources. Specifically, hillside slippage, home sewage treatment systems, stream bank erosion, and a historic industrial point source can be seen as sources of impairment.

The main stem of the Chagrin River has incised into the glacial deposits, forming a steep valley. Problems in this area were historically attributed the effluent discharge from upstream IVEX, formerly Chase Bag Co. (discussed under Upper Main Branch: Beaver Creek-Chagrin River) and numerous problems arise from the suburban development that predominates in this watershed. The effects of urbanization are exacerbated by steep slopes and poor soils. Soils formed in silty and clayey glacial sediments on steep slopes in Moreland Hills and further upstream in Cuyahoga County exhibit evidence of hillside slippage. Further, once on top of the valley, primarily on the west side of the river, urban/suburban development has encroached on existing stream channels. Many of the headwaters of these tributaries have been affected by urban runoff. Evidence of stream bank erosion exists at several locations as discussed below. Selected other tributaries also show evidence of stream bank erosion and property loss. Impervious cover in these areas is often a contributing factor to the changing hydrologic regime of these tributaries and increased stream bank erosion.

11.3.1 Main Stem of Chagrin River

From 1978 to 1987, the main stem of the Chagrin River downstream to river mile 4.0 was designated as Exceptional Warmwater Habitat (EWH). The 1987 Ohio EPA study showed concerns upstream of the confluence of the Upper Main Branch and Aurora Branch near Chagrin Falls due to fecal coliform bacteria and nutrient enrichment downstream of the Chagrin Falls WWTP and increased solids deposition from the Chase Bag Company. Concentrations of cadmium, lead, copper and zinc were elevated at river mile 29.8 upstream of this HUC, but non-elevated for all parameters near the mouth of the Chagrin River. Following the 1987 Ohio EPA study the main stem use designation was changed to WWH and the river was determined to be in full attainment of those standards for most of its length with partial attainment at river mile 25.3 and 12.5.

The 1990 study of freshwater mussels (Unionidae) by Michael Hoggarth of ODNR showed that this segment of the main stem of the Chagrin River downstream from Chagrin Falls supported five species of mussels. A more extensive community of mussels was found upstream of Chagrin Falls in the upper main branch. None of the freshwater mussel species found was rare. The study further noted that any threat that reduces habitat diversity, water quality, or substrate stability has the potential to significantly reduce the freshwater mussel species diversity.

The 1995 Ohio EPA noted that increased impacts from IVEX discharges lowered macroinvertebrate and fish community scores and elevated concentrations of mercury downstream of this facility. Similar to previous sampling results, total suspended solids and biological oxygen demand (BOD) associated with the IVEX discharge appeared to be the major biological impairment in this area. This study also noted areas of stream instability being exhibited by eroded stream banks, shifting sand and gravel (particularly in Hunting Valley upstream of Fairmount Road), and destabilized riffles. These instability problems appear to be attributable to increased stormwater flows due to increased development. In addition, nutrient enrichment was noted as an impairment along this reach and noted that continued attainment

would be further threatened if nutrient loadings from WWTP and stormwater discharges continued to increase. The 1995 sampling concluded that the Chagrin River was in full attainment of WWH standards except upstream of State Route 87 (RM 24.2) and at the Rodgers Road bridge (RM 13.0) that were both in partial attainment.

Based on 2003-2004 sampling the Chagrin River is in full attainment of WWH standards along the entire reach of the Chagrin River in this HUC. In addition the Chagrin River has been designated as Seasonal Salmonid (SSH) from Chagrin Falls (RM 29.65) to the mouth.

In 2012 and 2013 Lake Metroparks (LMP) completed 2 projects immediately adjacent to the Chagrin River on the Pleasant Valley Park property (river mile 10.7-11.7). Lake Metroparks acquired the Pleasant Valley Park along the Chagrin River near the Pleasant Valley Bridge in 2007. In 2012, LMP removed 650 linear feet of earthen levee along the Chagrin River to enable the river to access its historical floodplain, removed 9.2 acres of gravel driveways and nursery growing areas, crushed drainage tile and regraded the property to restore a historical 3.5 acre wetland. Further floodplain restoration re-established 17 acres of floodplain forest and meadow. This project increased floodplain storage, enhanced water quality treatment and improved wildlife habitat along the Chagrin River in Willoughby Hills and downstream communities. In 2013, LMP removed additional level and created fishing access just upstream of the Pleasant Valley bridge. An additional section of stream downstream still has a levee which could be removed to further restore this section of the Chagrin and provide floodplain access and forested riparian corridor.

In February 2011 the Gates Mills dam blew out during a high water event. The removal of this dam allowed steelhead to migrate upstream of this barrier and most of the former dam pool has stabilized naturally forming a series of riffle structures. At the former dam location – portions of the dam remain and lower water levels in an area upstream exposed non-natural rock and paving materials dumped along the stream bank. Removal of these non-natural features is recommended to naturalize this corridor and promote long term stability. In 2012 a streambank restoration project in Hunting Valley along Chagrin River Road near Shaker Blvd. incorporating vegetated riprap to stabilize the stream bank and serve as a demonstration project for this practice.

11.3.2 Gully Brook/Deer Creek (RM 5.54)

Gully Brook drains into the Chagrin River at river mile 5.5. In the City of Wickliffe, this stream is called Deer Creek. Approximately 10% land cover in the subwatershed is major roadways, including portions of I-90 and I-271. Gully Brook shows some dramatic effects of urban stormwater runoff with high conductivity due to salt and stream channel instability. Along the lower reaches, the stream has become entrenched. The result has been severe stream bank erosion and sedimentation problems. Ohio EPA conducted ICI evaluations in 2003-2004 and noted this tributary has a marginally good community composition that meets WWH expectations. Macroinvertebrates were noted in small stick riffles and bedrock fragments. Ohio EPA added SSH to the WWH use designation of Gully Brook, based on observations from Lake SWCD staff.

The City of Willoughby Hills retrofitted a portion of the Community Center parking lot with SWIF funding in 2013. This retrofit will minimize the amount of runoff draining directly to Gully Brook and is being monitored by CRWP as a part of our NERRS Science Collaborative project. Several sections of this stream are protected by Lake Metroparks or owned by the City of Wickliffe. In 2003, the US Army Corps of Engineers, CRWP, Lake SWCD, and Lake Metroparks investigated several restoration options including:

- Nehl's Park in the City of Wickliffe. Approximately 750 linear feet of the main stem of Deer Creek runs directly through the park. The stream has little or no canopy throughout the park.

Potential restoration projects in the park include planting a wooded riparian corridor through the park and possible floodplain wetland development.

- I-90/St. Rt. 91 Exit Keyhole in the City of Willoughby Hills. The stream corridor runs through the bottom of this very steep exit ramp keyhole. A potential project could incorporate stormwater detention/retention in this area.
- Manakiki Golf Course, owned by Cleveland Metroparks, and Green Ridge Golf Course, owned by the City of Wickliffe. Possibilities for restoration on the properties include:
    a. Restore streams onsite and at property boundaries to natural stream channels.
    b. Retrofit the existing ponds to water quality basins or wetland detention.
    c. Restore native vegetated buffers along streams that are currently mowed to the edge.
    d. Incorporate LID stormwater management practices like bioretention cells and permeable pavements.
- Pete's Pond located behind Wickliffe High School. Restoration and recontour outlet channel from Pete's Pond, create natural stream channel or extend wetland community along a wider swale. This property is now managed by Lake Metroparks as the Pete's Pond Preserve.
- City of Wickliffe Property downstream of Pete's Pond and Nehl's Park that is already subdivided, but is currently owned by the City of Wickliffe. On the west side of the property, the stream is entrenched and has areas with unstable stream channels. However, the riparian corridor is an intact second growth forest community. Towards the west end of the property, a large, high quality wetland complex exists due to historic beaver activity. There does not appear to be any recent beaver activity. Most of these properties are heavily browsed by deer populations and would benefit from activities to control non-native plant species including *Rhamnus frangula, Rosa Multiflora*, *Berberis thungeii*, *Ligustrum vulgare*, *Phragmites australis*, *and Phalaris arundinacea*. Restoration opportunities in this area should minimize impact to the forested riparian corridor and existing wetlands. As of 2011, Lake Metroparks is investigating opportunities for conservation easements or lease management agreements for these properties.
- Retrofit additional stormwater and decorative recreation ponds to incorporate water quality functions.
- Identify potential locations for day lighting buried headwater streams.
- Identify locations for stabilization (ex. grade control riffles) along existing headwater streams

Ohio EPA noted that future surveys are recommended to determine status of aquatic life use, sources of salt runoff, and effects of urban runoff on stream channel stability.

11.3.3 Caves Creek (RM 11.52)

Lake SWCD completed an analysis of the headwater streams in this subwatershed. Of the 19 headwater streams assessed 68% were Class III-PWH, 21% Class II-PHW and 11% Class I. In 2004, Ohio EPA noted Caves Creek is a high quality stream, but some impacts of stormwater were noted including moderately imbedded substrates. An abundance of pollution tolerant fish, longnose dace, and a low number of sensitive species and 8 young of year (YOY) steelhead were collected in this creek in 2004. Care should be taken to manage stormwater and maintain tree canopy in this tributary watershed. Stream and wetland restoration and removal of impoundments at the previous Orchard Hills Golf Course now owned by Geauga Park District will assist to maintain the CWH use in this subwatershed. Geauga Park District created a stormwater wetland and bioretention to treat runoff from the new park parking lot and shelter. North of Orchard Hills, there is a closed Waste Management landfill facility with the main channel of Caves Creek flowing along the north side. CRWP continues to investigate restoration projects in this area. Ohio EPA designated Caves Creek as CWH and notes the stream is in full attainment.

11.3.4 Beecher's Brook (RM 14.88)

Beecher's Brook drains 1.81 square miles with headwaters in Mayfield Heights, then flows through Mayfield Village and enters the Chagrin River at river mile 14.88 in the Village of Gates Mills. Sampling

by the Cuyahoga County Board of Health indicates this stream is likely being impacted by HSTS, shown by elevated bacteria and phosphorus levels. Mayfield Village has protected reaches of this stream, but the upper reaches are channelized and impacted by stormwater and retrofit opportunities should be explored wherever possible. A created series of waterfall step structures were constructed along this tributary east of State Route 91. This feature was created to stabilize this eroding area. The Cuyahoga County Hickory Hills WWTP discharge was eliminated in 1996, Ohio EPA recommends sampling this tributary to determine how biology has responded to the elimination of WWTP discharge.

11.3.5 Upper 40/Foster's Run

This stream has been dramatically affected by stormwater runoff. Sediments contaminated with heavy metals have been suspected as the cause of the problems. Extensive impervious cover exists in the headwater areas of this subwatershed. In addition, portions of the stream have been channelized to accommodate the increase in stormwater runoff in this area and to reduce local flooding and erosion. This however resulted in runoff more quickly reaching the lower portions of the watershed, increasing stream bank erosion and washing out portions of a road.

As this subwatershed developed nearly all of the floodplain, natural channel structure and wetlands were eliminated from this stream. Mayfield Village in cooperation with Gates Mills and the Cleveland Metroparks completed a stream restoration project that restored 2 areas of floodplain upstream along SOM Center Road and daylighted the stream that has been encased in a pipe since the 1920's. The stream restoration was completed in summer 2005. Mayfield Village installed permeable paver sand bioretention at Wiley Park and the police department to promote infiltration and restore natural stream flows. Ohio EPA has not completed sampling on this tributary.

11.3.6 Tributary to Chagrin (RM 15.42)

This small tributary has been found to contain many sensitive macroinvertebrate taxa and young of year rainbow trout. It has been classified as coldwater habitat. It is potentially threatened by suburban expansion.

11.3.7 Pepper/Luce Creek (RM 22.81)

This stream drains 9.3 square miles and has a steep gradient of 53 feet per mile. Several small wastewater treatment plants are located in this basin. Also, land use changes consisting of urban and suburban development are continuing to alter the runoff characteristics. While fish diversity is rated in the exceptional range, the macroinvertebrates scored only marginally well. Erosion and sedimentation problems exist. Some of the existing ponds and lakes have been filled with sediment and have had to be dredged. The amount of intact riparian area has been greatly reduced in the more developed areas. This tributary is showing evidence of stream bank erosion. Storm sewers discharge to the stream as a result of urban/suburban development. Several inline impoundments through the golf courses and West Hill Colony subdivision should be evaluated for removal or moving impoundments offline and restoring the stream through this corridor.

This stream was in full attainment of WWH in 1995 and that use was threatened along most of this stream reach. The IBI score in 1995 of 50 fell to 38 in 2004. A low abundance of high quality fish was also noted in 2004 that may indicate episodic events such as upstream WWTP discharges. However the stream is still in full attainment of its WWH use. Since this sampling event the City of Pepper Pike adopted riparian setbacks. Additional opportunities for riparian protection and stormwater retrofits must be investigated along this stream.

In early December 2010 work was begun on converting the Pepper Pike Creekside WWTP, located off SOM Center Road between Pinetree Road and Shaker Boulevard, to a pump station. The WWTP served

350 homes, the Orange School District and the Lander Circle business district. Conversion to a pump station will allow for additional flow in the future and less discharge into the Chagrin River. The Creekside WWTP will be converted to a pump station and connected to the NEORSD's Easterly WWTP via a line up SOM Center Road by April 2012.

The City of Pepper Pike has completed several small stormwater retrofit projects with funding from the NEORSD small grants program and also retrofitted a portion of the City Hall parking lot with permeable pavers and a grassed bioretention cell to manage stormwater from these areas. CRWP has also worked with Ursuline College in Pepper Pike on several projects to better manage runoff and stream quality on their campus including: retrofit of patio at Pilla Learning Center to porous pavers and a planned stream restoration and bioretention project slated for a 2014 construction.

11.3.8 Griswold Creek (RM 23.82)

Griswold Creek is tributary to the main stem of the Chagrin River as represented by 12 digit HUC 04110003-04-02 which includes the main branch of the Chagrin River below the Aurora Branch to above the East Branch. Griswold Creek is located in Chester and Russell Townships and flows into the Chagrin River in the Village of Hunting Valley. Since the forming of CRWP in 1996, CRWP staff visited numerous property owners along Griswold Creek to address concerns about erosion, flooding and channel instability. In addition, Geauga Soil and Water Conservation District (SWCD) and Russell Township officials and staff have visited property owners along the creek with similar concerns. To facilitate a watershed restoration approach to these erosion and flooding issues, CRWP drafted a Griswold Creek Watershed Plan and presented it to Russell Township, Geauga SWCD and Griswold stream owners to determine if there is interest in developing a strategic watershed approach to promote a more stable stream channel and provide sustainable solutions to streambank erosion and flooding.

Griswold Creek is a dynamic stream that has been experiencing continuous erosion and down cutting of the channel. In May 1989 during a storm event, a privately owned dam, Kirkham Dam was overtopped and breached. During the same storm event the Applebaum dam, just downstream of the Kirkham dam, also overtopped and was substantially damaged. In late 1990, the damaged Applebaum dam was breached. These dam breaches caused downstream reaches to change due to the change in hydrology once these dams were removed. Numerous areas of Griswold Creek exhibit extreme channel instability through stream bank erosion and down cutting stream channels. Portions of Griswold Creek are still adjusting to these changes up stream.

Continuing development can be expected to change the hydrology of Griswold Creek, suggesting additional stream bank erosion. Numerous impoundments from old road beds and lowhead dams affect fish passage and temperature. More recently, storm events over the 2010 Memorial Day weekend caused additional erosion and flooding.

Griswold Creek drains 7.2 square miles of land made up of 37% urban, 61% forested, and 2% agricultural land uses as shown in Figure 39. Approximately 8% of the

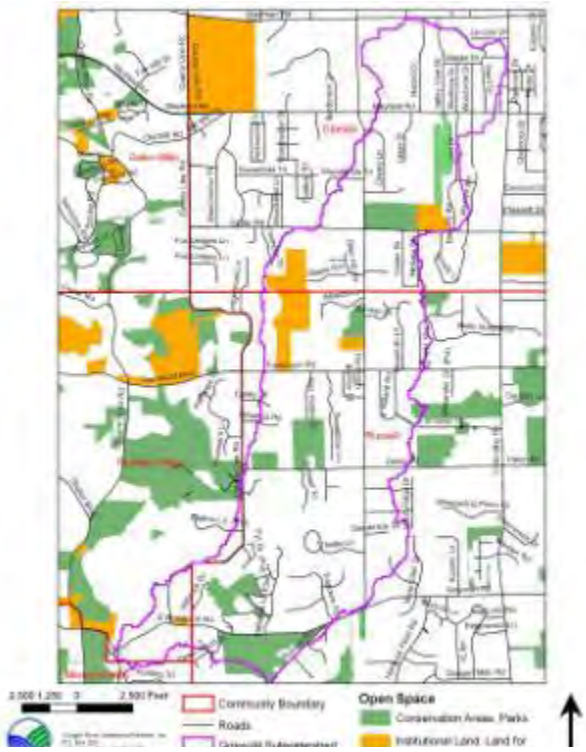


Figure 36: Open Space in Griswold Creek

Griswold subwatershed is protected through parks and conservation areas as illustrated in Figure 38. Russell Township and the Village of Hunting Valley participated in the Balanced Growth Program to identify priority conservation areas (PCAs) and priority development areas (PDAs) for their community and endorsed their PCA and PDA map (Figure 39). At this time, no priority development areas were noted in the Griswold Creek watershed. Designated PCAs include riparian corridors, existing parks and conservation easements, and large parcels that may be possible open space or conservation easements or could be developed using conservation development.

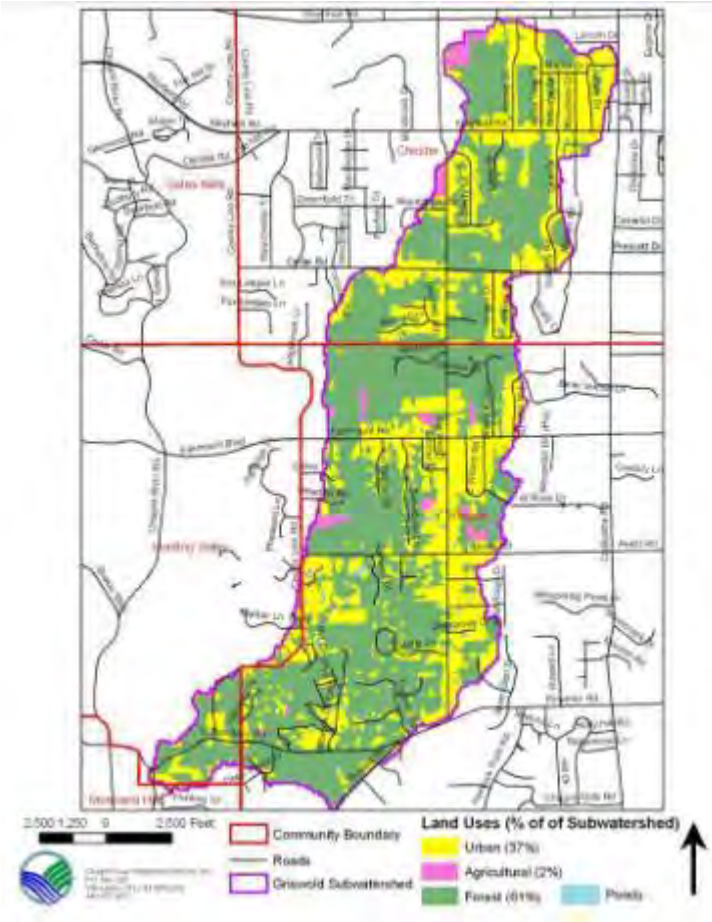


Figure 39: Land Use in Griswold Creek

Figure 40: PDAs and PCAs in Griswold Creek

Griswold Creek is designated as a cold water habitat (CWH) stream. Data from a private environmental consultant in 1996 highlighted that Griswold Creek was in full attainment of water quality standards. However in 1995 Ohio EPA data determined that 0.9 miles of the stream were only in partial attainment of water quality standards. In the past, failing septic systems and increased stormwater runoff have contributed to the problems occurring in the watershed. Evidence of stream bank erosion exists at many locations. Portions of the tributary are vulnerable to erosion because of the presence of erodible glacial till. In 1999, the Valley View wastewater treatment plant (WWTP), operated by Geauga County, was constructed in Chester Township south of Route 322. Bacteria sampling in 2003 noted a significant improvement downstream of this WWTP.

In 2004, Ohio EPA noted obvious stormwater impacts in the lower reach. At Fairmount Road, Griswold Creek is in partial attainment of the CWH use, however the lower reach at Falls Road is in non

attainment. The fish community composition and quantity remained stable from 1995 to 2004 sampling. There was a slight improvement in the macroinvertebrate community at the mouth of the creek sampling site from 1995 to 2004. Causes of non attainment are habitat alteration and thermal modifications. The sources of these impairments are discharge from the WWTP, suburban development, streambank modification, removal of riparian vegetation and nonpoint source stormwater runoff.

The area treated by the Valley View WWTP is the only area served by central sewer within the subwatershed. In addition to this WWTP, small WTTPs are also located within the subwatershed at Laurel School, Hillbrook Club, and Metzenbaum School. The remainder of the watershed is served with onsite home sewage treatment systems (HSTS). Approximately 950 HSTS are located within this subwatershed. The HSTSs are installed and regulated by the Geauga County and Cuyahoga County Boards of Health. Cuyahoga County Board of Health requires operational permits for HSTS and sanitarians conduct sewage system evaluations upon request, during nuisance investigations, or as a part of a sewage system testing project area. Geauga County Board of Health conducts a point of sale HSTS inspection program.

Figure 41 below notes locations of the property owners and stream concerns that CRWP has noted through watershed investigations and site visits. The notes and recommendations below are a summary of CRWP site visits in the Griswold Creek subwatershed.

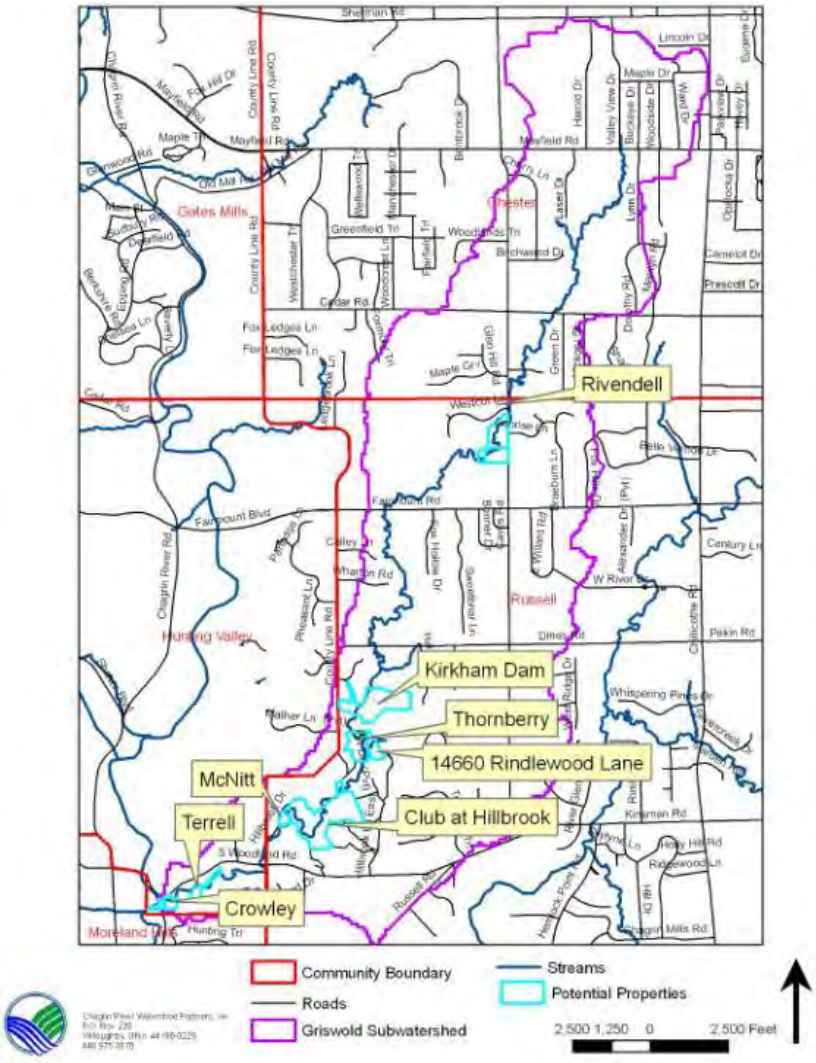


Figure 37: Stream Concerns in Griswold Creek

Rivendell Subdivision

In June 2007 CRWP was asked by Russell Township Board of Zoning Appeals to review the Rivendell Subdivision Restoration Plan for the area behind Sublots 11 and 12 and make recommendations. This area is under a conservation easement held by the Russell Township Park Board. Under the easement no structures were to be built in the easement area. During the initial construction phase of the Rivendell Subdivision a stormwater detention pond, designed to be a water quality best management practice, was constructed in the easement area. Based on the site conditions and easement contract language, CRWP recommended the stormwater detention pond be filled and a new detention facility built outside of the easement area. CRWP recommended that the filled area be planted with vegetation and deciduous trees, and maintain the area to ensure at least 80% of trees survive and vegetated cover is established. A site visit was conducted with the Township Zoning Inspector on June 25, 2008 to evaluate if the property owner had completed the recommendations. The stormwater basin had been filled and 40 trees had been planted. The area had not been stabilized with additional vegetation leaving exposed bare soil, and several trees were wilted and stressed. Based on the site conditions CRWP recommended additional seeding on exposed soil, installation of erosion and sediment control BMPs until vegetation covered at least 80% of the area, and to reevaluate the area in the fall and spring, and reseed as necessary. The following photos show Griswold Creek as it flows through this site and the relocated stormwater basin. This basin must be maintained throughout its life.

Figure 38: Relocated Rivendell Detention Basin

Figure 39: Griswold Creek Flowing Through Rivendell

Downstream of Dines Road
CRWP has not visited the property downstream of Dines Road, however significant erosion was noted along the road and the downstream property following the Memorial Day 2010 flood event. Erosion in the road right of way has been repaired.

Figure 40: Erosion Downstream of Dines Road

Former Kirkham Dam (Currently owned by Gay Cull)
CRWP investigated this site as a possible stream restoration, but has not presented this plan to the property owners. The potential restoration discussed below is downstream of the breached dam. This reach has suffered impacts from dam breach, entrenchment, and riparian vegetation removal. The surrounding land is recovering from past use and there is a small livestock operation to the west. Portions of the site already contain streamside vegetation such as willows but a majority of the site could benefit from supplemental plantings. This project provides an opportunity to establish a wide riparian zone; as much as 150 feet on either side. This site may also provide the opportunity to establish floodplain wetland communities or other flood storage areas. Additional opportunities may be present directly upstream of this road crossing as well.

Figure 41: Downstream of Kirkham Dam

Thornberry (former Applebaum Lake Dam site)
On December 12, 2006, CRWP visited the Thornberry property at 14357 Hillbrook Lane North for the first time and has made several more visits to follow up and provide input on additional concerns. At the time, the Thornberrys were relatively new property owners (1 year) concerned about bank erosion in two areas. Griswold Creek used to run through an inline Applebaum Lake, but the dam was breached in 1990. Griswold Creek now flows around an off-line pond. Two main areas of concern are present on this property. One area of concern is at the north end of the pond where Griswold Creek enters the property and makes an abrupt turn to the east as seen in the picture below. The stream is migrating into old fill when the stream was blocked from the pond. The erosion area is not threatening the house or pond but the erosion rate is extreme along approximately 150 feet of the stream bank. Bank heights are approximately 5 feet from the water surface. This area was stabilized in 2006/2007, but was eroded again during the Memorial Day 2010 storm event.

Figure 42: Erosion North of Pond, Griswold Creek

The second erosion area is along Griswold Creek on the eastern side of the pond. This area has the potential to cause more serious problems as this slope is part of the dam forming the pond on the property. The stream had eroded approximately 75-100 foot long section of the pond berm (river right). The top of berm between the pond and bank edge was narrowed from erosion to only 15 feet wide. Bank heights were severe at 10-15 feet. Water seepage (flow) from the pond was noticeable in the exposed bank at two areas. The owner installed bank pins several months prior to the picture on the left below and observed lateral erosion of over 2 feet of bank. As the threat of berm failure was high, the owner regraded the stream banks and stabilized with willow postings in 2007. The willows became well established, however an additional erosion area was observed after the Memorial Day 2010 flood.

Figure 43: Thornberry Bank Erosion, 2006

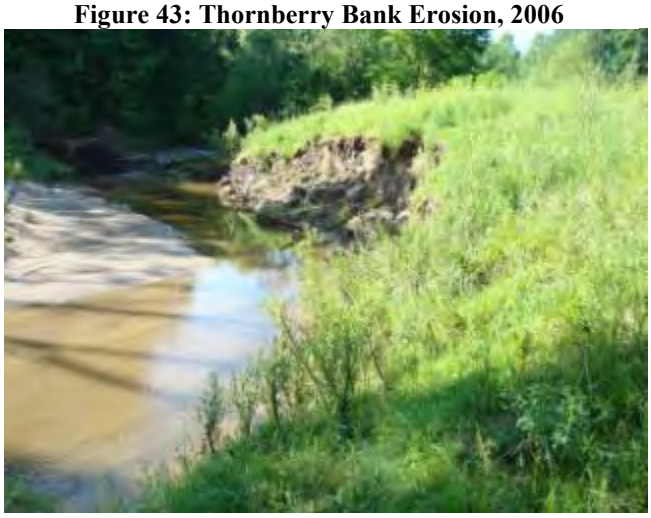


Figure 44: Thornberry Bank Erosion, 2010

Additional work was completed in 2012 that caused the stream to cut off a meander bend and cut a new shorter channel which should be observed for future instability. Restoration at this site could be accomplished, but would likely result in eliminating or significantly reducing the size of the existing pond which is not acceptable to the property owners.

Boykin - 14660 Rindlewood Lane

On November 26, 2003, CRWP visited the then-Boykin property at 14660 Rindlewood Lane. The property has since changed hands. In 2003 the erosion occurring on this small tributary to Griswold Creek appeared to be due to erosion and down cutting occurring on the main channel of Griswold Creek. This tributary enters the main channel of Griswold Creek directly across from the berm on the Thornberry property. At this time CRWP recommended the following actions to prevent further erosion and to stabilize the stream banks on this property:

- Install grade control structures such as step-pools in the stream channel,
- Reestablish the floodplain to allow for flood flows to spread out and reduce the stream energy during storms,
- Reestablish streamside vegetation once work the stream channel has been stabilized.

Figure 45: Examples of Headcut Erosion

The headcut erosion appears to have been triggered by the incision of Griswold Creek. When a stream rapidly down cuts to a new elevation it abandons its tributaries at the previous elevation. In order to adjust for this elevation difference, the tributaries initiate a headcut to meet the new elevation of its receiving stream. Effects of a headcut move upstream. While this process has most likely been occurring for some time at this small tributary, it had been accelerated in the 1-3 years prior to the site visit as it moves through the steeper slopes of the headwater tributary. The headcut will continue through the valley until it stabilizes. Unfortunately, judging by the elevation differences observed during the site visit, the headcut will likely continue for a significant distance. The stream channel upstream of the problem appeared stable at that time of the site visit. Further reaches of this tributary may have been impacted if the head cut was not stabilized.

A follow up site visit to this property in 2013 showed that the stream had stabilized the lower reaches of this stream and was establishing a floodplaini n the lowered stream corridor.

Marsha Davis – 14771 Hillbrook Lane North

On December 12, 2006, CRWP visited the Davis residence at 14771 Hillbrook Lane North to investigate concerns about erosion along Griswold Creek. This property is located on a meander and is downstream of the Thornberry property approximately 1,000 feet. Mrs. Davis was worried about several trees that were leaning. The trees had been leaning for some time and were about 1/3 eroded and undercut at their bases, but had good root structure. The meander has gabion baskets that were installed prior to 1997 and were in surprisingly good condition except near the upstream end of the gabions. During high water events the abrupt ending to the gabions causes back water eddy erosion creating a cut in the bank. The cut could erode behind the gabions causing instability. It is unknown if the gabions were installed at an angle or have slumped, but the angled nature of the gabions allowed for deposition of silts and sands. Grasses and several woody plants were growing on the gabions. CRWP suggested that the owner should encourage more growth or try to install woody vegetation on the bank as a stabilization measure.

Figure 46: Old Road Bed Crossing Griswold Creek

Club at Hillbrook

CRWP visited the Club at Hillbrook on July 14, 2010 to evaluate erosion concerns and potential solutions. Storm events over 2010 Memorial Day weekend caused additional erosion, particularly near the pool lawn area as observed in the picture below. The Hillbrook Club staff also noted concerns related to the old stone wall structures including erosion and a desire to maintain some of these structures.

Figure 47: Streambank Erosion at Hillbrook Club

Figure 48: Old Stone Structures at Hillbrook Club

CRWP made the following recommendations for the Hillbrook Club, but also noted the possibility of a larger watershed study and focused solutions.

- Cease mowing activities up to the edge of the stream bank and revegetate the stream bank creating at least a 10 foot vegetated strip along the stream.
- In areas with heavy erosion, use willow species as they have extensive root systems and can assist in providing structure and strength to the streambank soils. Willows can be installed using dormant staking along the stream banks in late fall or early spring.
- Consider expanding/creating flood storage capacity off the main stream channel in the existing low wetland areas or in the location of the old tennis courts.

McNitt Property - 14883 Hillbrook Drive

CRWP visited the McNitt property for the first time in July 2007. Three low head dam structures in various stages of disrepair are located on this parcel and eroding stream banks were observed at the time. CRWP made the following recommendations, many of which the property owner has completed.

- Lower the lowhead dam structure on the northern end of your property. The lowered area should be at least five feet wide and one foot deep to help direct the flow of the creek to the center of the stream channel during base flow condition.
- Cease mowing activities up to the edge of the stream bank and reestablish a vegetated riparian corridor. CRWP recommends a vegetated corridor of 120 feet for a stream with this drainage area. Given that this 120 foot corridor would encompass much of your property a minimum of 30 feet is recommended.
- Annual monitoring of these remaining structures to ensure their stability including annual photos from the same location to allow a good comparison from year to year.
- Bio-engineering stabilization such as vegetated rip rap and willow staking along the stream banks near Hillbrook Drive.

The following pictures show the property in 2007 and in 2010 (post Memorial Day). Note that work was completed to stabilize the right wall of the lowhead dam and a low flow cut made into the mid section of the dam. Willows are established just upstream. The area near Hillbrook Drive was stabilized using

gabion baskets by the Russell Township Road Department. These gabions were damaged during the Memorial Day storm event.

Figure 49: McNitt Property 2007, dam structure

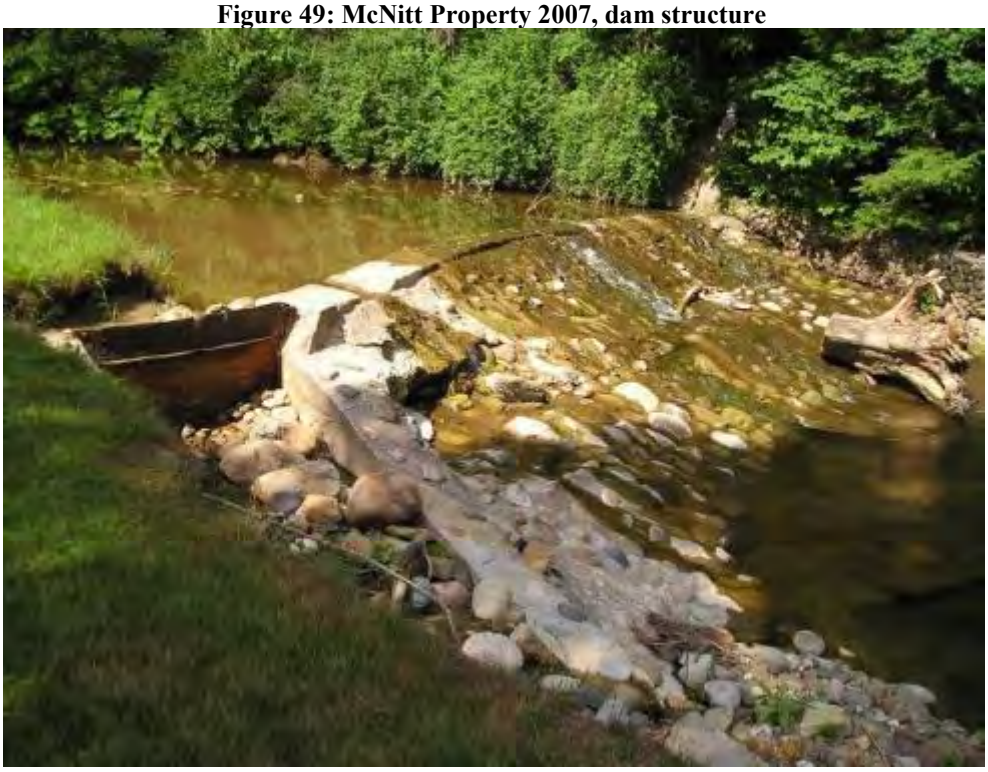


Figure 50: McNitt Property 2010, dam structure

Figure 51: McNitt Property 2007, streambank erosion

Figure 52: McNitt Property 2010, gabion structures

Additional old road bed and grade control structures along Hillbrook Drive have been noted by CRWP, however CRWP has not been in contact with these property owners to discuss the concerns and opportunities related to these structures. In addition to these site visits in Russell Township, CRWP has completed site visits to several downstream properties in the Village of Hunting Valley. It is also important to note that Ohio Department of Transportation has completed significant stabilization work to protect State Route 87.

Terrell Property - 450001 Falls Road

On October 26, 2009 CRWP walked the property on 450001 Falls Road to discuss slope stability along Griswold Creek. The photo below is taken from the top of this slope. The slope leading down to Griswold Creek is very steep in several places and serious erosion has been occurring for a number of years. Adjacent parcels have experienced as much as 60 feet of lateral erosion at the top of this slope above Griswold Creek. The toe of the slope has small trees and shrubs growing along the edge of the stream that indicate that the toe of the slope has been stabilizing, however, slope failures along this area are still occurring. CRWP recommended the following:

- Allow vegetation to grow along the slope and do not deposit leaves, grass clippings, or other materials over the top of the slope as these materials can smother slope vegetation. Vegetation along the slope can help to stabilize the slope through the vegetation's root structures.
- Do not mow the area regularly at the top of this slope. High, rough grasses and other dense vegetation will slow the flow of any water over the top of the slope and protect against future erosion.
- Retain a slope stability expert to investigate the concerns about this slope and determine next steps to slow slope erosion.

Figure 53: Terrell Property, Griswold Creek

Crowley – 44001 Falls Road

The Crowley property is just downstream of multiple repairs along State Route 87 and follows the river to the mouth on the downstream side of Falls Road. A bank stabilization project was completed on this property as the stream bank had eroded over 35 feet and was jeopardizing the Crowley barn. The photos below show the latest ODOT repair near State Route 87 with the Crowley bank stabilization downstream in the background and a view of the stabilization work from Falls Road.

Figure 54: ODOT Repairs Near Crowley Bank Stabilization

Figure 55: Stabilization Work Viewed from Falls Road

11.3.9 Unnamed Tributary at RM 23.93

Stream receives effluent from Moreland Hills Quail Hollow WWTP. No surveys have been completed on this tributary and it should be targeted for future study. A HHEI completed by Ohio EPA and this tributary was determined to be a Class III headwater stream. The Quail Hollow WWTP was converted to a pump station and connected to NEORSD's Easterly WWTP via a line down SOM Center Road in 2012.

11.3.10 Unnamed Tributary at RM 24.19

Stream receives effluent from Geauga County Scarsdale WWTP. No surveys have been completed on this tributary and it should be targeted for future study.

11.3.11 Willey Creek (RM 26.31)

Willey Creek drains 5.2 square miles and flows into the Chagrin at river mile 26.31, and was determined to be in full attainment of CWH standards in 1995. Sampling of fecal coliforms by Cuyahoga County Board of Health in 1998 indicated elevated levels of fecal coliforms were likely due to failing HSTS and semi-public sewage systems. This water body flows through urban/suburban development. As a consequence, it shows evidence of bank erosion and other effects of urban stormwater runoff. Roadway segments in this area of the have been effected by the stream bank erosion, threatening road beds. There have been many anecdotal reports of erosion problems in this area. The Woodbran and Jackson Valley WWTP discharge to this stream.

In 2009 water chemistry sampling, habitat assessments, and fish and benthic macroinvertebrate community surveys were conducted by NEORSD as part of their *2009 Pepper Pike/Moreland Hills Publicly Owned Treatment Works Baseline Assessment Study Prior to Decommissioning Plan.* The Jackson Valley WWTP is scheduled to be decommissioned, converted to a pump station, and connected to NEORSD's Easterly WWTP via the SOM Center Relief Line by April 2012. The baseline assessment was conducted prior to decommissioning, and a second assessment will be conducted post-connection to determine the impact of the Jackson Valley WWTP on Willey Creek's fish, habitat, and macroinvertebrates.

The NEORSD sampling location on Willey Creek is located at RM 1.00 at 37855 Jackson Road, downstream of the Jackson Valley WWTP. Water chemistry samples were collected at this location five times between July 22 and August 18 in 2009. The Jackson Valley WWTP was not found to be in exceedance of its water quality maximums or minimums. Willey Creek was assigned a QHEI score of 80 at this location, indicating excellent habitat rating for WWH attributes, including good/excellent substrates, boulder/cobble/gravel substrates, moderate/high sinuosity, extensive/moderate cover, maximum depth greater than 40cm, fast current/eddies, and no channelization. While rated low to normal overall embeddedness, high to moderate riffle embeddedness was noted for this location. The site on Willey Creek received the highest QHEI of any of the sites sampled and should be capable of supporting an exceptional warmwater habitat community, however, electrofishing results assigned an IBI score of 24 and a rating of Poor. No CWH-associated species were found at this location and the site had the second-lowest number of fish found in the headwater sites sampled. A predominance of pollution-tolerant fish and a lack of more sensitive species were also noted at the sample site. This indicates possible water quality impacts to the fish communities but could also be caused by natural barriers to fish migration downstream of the site.

Willey Creek was assessed an attaining ICI score of 36, with the lowest density of any of the sites sampled. 24 total taxa were collected, with a low percentage of pollution-tolerant organisms. Notable taxa found at the site were *Zavrelia*, *Boyeria grafiana, and Parametriocnemus.* The presence of these CWH-indicative taxa support Ohio EPA's designation of Willey Creek as CWH in 1997 and suggest that water quality is not a major factor impacting the macroinvertebrate community at the sample location.

The results of NEORSD's 2009 study indicate that a natural downstream migration barrier, not water quality, is impacting the fish populations of Willey Creek. The study recommends that additional sites should be sampled downstream of the barrier to more effectively determine any improvements.

Several stormwater retrofit projects have been completed in the Willey Creek watershed including Orange Village Sterncrest Road bioretention project and the Orange Village Community Center bioretention and pervious pavers.

11.3.12 Sulphur Springs (RM 26.68)

Sulphur Springs is a CWH stream with a Superior High Quality Waters antidegradation status with the lower reaches located in the Cleveland Metroparks South Chagrin Reservation. A population of brook trout from Quebec, Canada was introduced into this stream approximately twenty years ago. Since that time, a remnant population of Ohio native strain brook trout has been discovered and may be reintroduced in the stream in place of the Quebec strain fish that were recently removed. Although the water quality and temperatures of this stream are adequate to harbor this highly sensitive species of fish, there are concerns regarding the impacts of significant residential development in the upstream reaches of this tributary. The stream portion that flows along Hawthorne Parkway has road crossing culverts that act as barriers to upstream fish migration. A fifteen acre parcel containing most of the South Fork of Sulphur

Springs was protected by the City of Solon and WRLC through the WRRSP program in 2007. In 2013, Cleveland Metroparks and WRLC purchased a portion of a property upstream and proposes to restore additional headwater wetlands (pending 319 grant) on this property, formerly the Lambert Property. CRWP is working with Cleveland Metroparks to monitor stream flow and temperatures to target potential stormwater retrofits in residential neighborhoods. The North Fork of Sulphur Springs, locally called Boulder Creek, was the site of a stream restoration project in 2005 completed by the City of Solon with funding through the Great Lakes Commission, and in June 2011 CRWP in partnership with Cleveland Metroparks and Emerald Necklace Chapter of Trout Unlimited was awarded a grant from the Great Lakes Basin Fish Habitat Partnership for monitoring and assessment of Sulphur Springs as a potential site for reintroduction of native Ohio brook trout. 400 linear feet and 0.5 acres of riparian corridor were restored in an area impacted by a historic impoundment in late 2012.

11.3.13 Summary and Recommendations

Stream bank erosion and sedimentation are expected to continue to be a problem in the many small tributaries draining into the Chagrin River, particularly those located on the more developed side of the river (west side). Since many of the communities located in this area are subject to Phase II regulations, increased awareness of local problems in response to the development of local stormwater plans are expected to occur, increasing the likelihood that solutions will be implemented over the long term to address identified problems. While additional land use changes are expected to occur on the east side of the river, significant land use changes are not expected due to current zoning. However, land owners modifications to stream channels will continue to be problematic.

CRWP works communities on development regulations that will assist to maintain existing natural resources and provide green stormwater management. Many communities have adopted riparian setbacks, conservation development, stormwater management and erosion and sediment control regulation and CRWP further recommends the adoption of the following:

- Hunting Valley: Erosion and Sediment Control and Comprehensive Stormwater Management
- Chester Township: Riparian and Wetland Setbacks, Conservation Development, and Parking Regulations that decrease unused impervious surface
- Russell Township: Revise existing Planned Unit Development to a Conservation Development code.
- Willoughby Hills: Conservation Development
- Mayfield Heights & Wickliffe: Parking Regulations that decrease unused impervious surface
- Solon: Riparian and Wetland Setbacks, Conservation Development, and Parking Regulations that decrease unused impervious surface

Because of the land use characteristics, stormwater runoff from residential areas is expected to continue to be a source of lawn pesticides and nutrient loadings to the Chagrin. CRWP has worked with Pepper Pike to develop a training protocol for landscapers working in the City and will continue to train the landscaping community and area residents on the importance of management of lawn chemicals, stream corridors, and stormwater from individual properties. Additional outreach and education to property owners and communities on better ways to manage runoff from their properties to infiltrate water will help to restore and protect the tributaries to the main branch of the Chagrin, particularly coldwater habitat streams. Erosion along the several steep slopes existing along the river is expected to continue to be a problem.

Additional restoration and stormwater retrofit projects to restore those areas where streams have been impacted by impoundments, channelization and hydromodification and installed of LID stormwater control measures to retrofit existing development that was constructed before stormwater management was required.

11.4 Upper Main Branch: 04110003-03-04

The Upper Main Branch of the Chagrin River is represented by 12 digit HUC 04110003-03-04 and is comprised of the Upper Main Branch Chagrin River downstream to its confluence with the Aurora Branch, except Silver Creek. Subwatersheds included in this segment are Beaver Creek, Dewdale Creek, Springbrook, Woodiebrook, and numerous unnamed tributaries. The 305(b) and 303(d) report identifies causes in this segment as mercury, unionized ammonia, chlorine, organic enrichment, thermal modifications, flow alteration, noxious aquatic plants, and other habitat modifications. Sources are identified as major industrial point sources, package plants, highway/road/bridge/sewer line construction, drainage/filling of wetlands due to development, natural, upstream impoundments, and onsite wastewater systems (HSTS).

Problems in the extreme downstream reaches of this subwatershed area have historically been linked to the effluent discharge from IVEX, formerly Chase Bag Co., and hydrologic and fish barriers due to the natural falls in Chagrin Falls and the two mill pond dams upstream of IVEX. Traveling upstream from Chagrin Falls and the IVEX facility, the first major tributary to drain in to the Upper Main Branch is Silver Creek, discussed below. The unnamed tributary at river mile 38.32, referred to as the Opalacka tributary, is the next major tributary followed by Dewdale Creek, then the river flows through the Rookery Park owned by the Geauga Park District. Upstream of the rookery the drainage area is dominated by upstream Bass Lake. Numerous named tributaries drain into Bass Lake including: Beaver Creek, Springbrook, and Woodiebrook.

Significant areas of wetland including several large wetland complexes around Bass Lake and The Rookery exist in this important headwater area. As CRWP's wetland study indicated, over 80% of the Chagrin River wetlands have already been drained or filled. Threats to these headwater wetland resources can be expected to continue. The river through The Rookery Park and the river reach southwest to Auburn Road have been previously channelized. The area most heavily affected is the Bass Lake to Rockhaven Road reach (RM 48.29-42.74). Approximately 1 mile of the 5.5 section has been channelized. Small dams have impounded another 1.2 miles. Road and bridge construction has impacted this area. Finally, significant channel clearing and stream bank modifications have occurred when a golf course was constructed just upstream of Rockhaven Road.

The 1990 study of freshwater mussels (Unionidae) by Michael Hoggarth of ODNR showed that this segment of the Chagrin River main stem supported seven species of mussels. The largest concentration of mussels was found upstream of Chagrin Falls. Two hundred twenty six (226) specimens were found upstream of Chagrin Falls along the main stem upstream to the intersection of Sherman and Auburn Roads in Munson Township. This represents 84% of the mussel population found within the Chagrin River watershed. None of the freshwater mussel species found was rare. The study further noted that any threat that reduces habitat diversity, water quality, or substrate stability has the potential to significantly reduce the freshwater mussel species diversity.

In the summer of 2003 CRWP worked with EnviroScience Inc. to evaluate 60 headwater stream sites in the Upper Main Branch watershed of the Chagrin River. This study included sampling sites in Auburn, Chester, Chardon, Chagrin Falls, Munson, Newbury, Russell, and South Russell. Headwater streams are small watercourses that generally drain less than 1 square mile. These streams are important because they provide essential flood control, erosion control, and water quality protection services throughout the watershed. The streams are also the ones most impacted during development and from increased stormwater flow. The status of the headwater streams, therefore, is an indicator of overall watershed quality. Our headwater stream study found that streams in the Upper Main Branch watershed are generally in good condition. However, numerous streams show impacts due to increased stormwater

volume and loss of riparian vegetation. For the Upper Main Branch overall, the study found 3% Class I, 60% Class II, and 37% Class III streams.

The study also showed that alterations to stream channels and removal of riparian vegetation have detrimental impacts on stream functions. These impacts can be seen through stream bank erosion, increased water temperature, and nutrient enrichment. Erosion can cause property loss and damage to infrastructure and nutrient enrichment can lead to unsightly and foul smelling algal blooms in local streams.

11.4.1 Upper Main Branch

In general, this section of the river is characterized by slower gradients and flows over glacial tills that in many areas are poorly drained. This is particularly true around Rookery Park, where adjacent wetlands are found. Because of changing land use conditions in this area, moderate to heavy silt cover and moderate to extensive substrate embeddedness exists.

From 1978 to 1987, the main stem of the Chagrin River downstream to river mile 4.0 was designated as Exceptional Warmwater Habitat (EWH). The 1987 Ohio EPA study showed concerns near Chagrin Falls due to fecal coliform bacteria and nutrient enrichment downstream of the Chagrin Falls WWTP and increased solids deposition from the Chase Bag Company. Concentrations of cadmium, lead, copper and zinc were elevated at river mile 29.8, but non-elevated for all parameters near the mouth of the Chagrin River. Following the 1987 Ohio EPA Study the main stem use designation was changed to WWH and the river was determined to be in full attainment of those standards for most of its length with partial attainment at river mile 25.3 and 12.5. In the 1991 Ohio EPA study, the Chagrin River upstream of IVEX was determined to be in full attainment, while the reach downstream of IVEX (previously Chase Bag), was considered to be in partial attainment of WWH aquatic life use. Despite improvements in operations at IVEX, total suspended solids and lower dissolved oxygen continued to be problems downstream of this facility. Cadmium, lead, copper and zinc levels in the stream sediments remain elevated and essentially unchanged from the 1987 levels.

In 1994, a major storm resulted in the breaching of the upper IVEX dam site. This resulted in dislocation of sediments accumulated behind the dam. Local officials responded and completed a stream restoration project to stabilize accumulated sediments including restoring a wetland on the site and making in stream modifications to reduce flow rates at the former dam outlet to reduce channel instability and erosion and sedimentation problems. The 1995 Ohio EPA studied noted that the impact of IVEX increased from previous studies with lower macroinvertebrate and fish community scores and elevated concentrations of mercury downstream of this facility. Similar to the previous sampling results, total suspended solids and BOD associated with the IVEX discharge appeared to be the major biological impairment in this area. The 1995 sampling concluded that the Chagrin River was in full attainment of WWH standards except downstream of IVEX at river mile 30.0.

In early 2005, the IVEX facility closed and the discharge was eliminated. As the redevelopment of this area is being investigated, lowering of the lower mill pond spillway was completed in 2012 with funding through the Ohio EPA 319 grant program to further improve and assure attainment of water quality standards. Data from the 2003-2004 sampling events showed an improvement along the main stem of the Chagrin River. The Chagrin River is in full attainment of WWH standards along the Chagrin River downstream of Sperry Road. Portions of the headwater reaches of the Chagrin River at Rockhaven Road (RM 42.8) and upstream of Fowler Mills Road (RM 45.3) are in partial attainment, caused by habitat and flow alterations. Upstream of Woodiebrook Road the channel is highly modified and is in non-attainment of WWH due to hydromodification and channelization. Directly upstream and downstream of Bass Lake, the Upper Main Branch is channelized and is largely connected to large wetland complexes. These

wetland complexes may be sources of low dissolved oxygen. Low DO is the cause of chemical non-attainment in this area.

11.4.2 Opalacka Tributary/Marsh Hawk Run (RM 38.32)

A subwatershed of the 12-digit HUC 041100030304 Upper Main Branch of the Chagrin River watershed, Marsh Hawk Run drains approximately 2.3 square miles and is located entirely in Chester Township (Geauga County). Marsh Hawk Run is tributary to the mainstem Chagrin River at RM 38.32. In 2004, Marsh Hawk Run was sampled by Ohio EPA and determined to be in non-attainment of its warm-water habitat (WWH) use designation.

The Marsh Hawk Run watershed contains 12% impervious cover, most of which is concentrated in the northwest section of the watershed near the intersection of Mayfield Road (SR 322) and Chillicothe Road (SR 306). The land cover in the watershed is 2% medium-intensity developed, 24% low-intensity developed, 21% developed open space (mowed and maintained areas), 44% forest, 5% agricultural and pasture land, 1% forested wetlands, and 3% scrub/shrub area as shown in Figure 56.

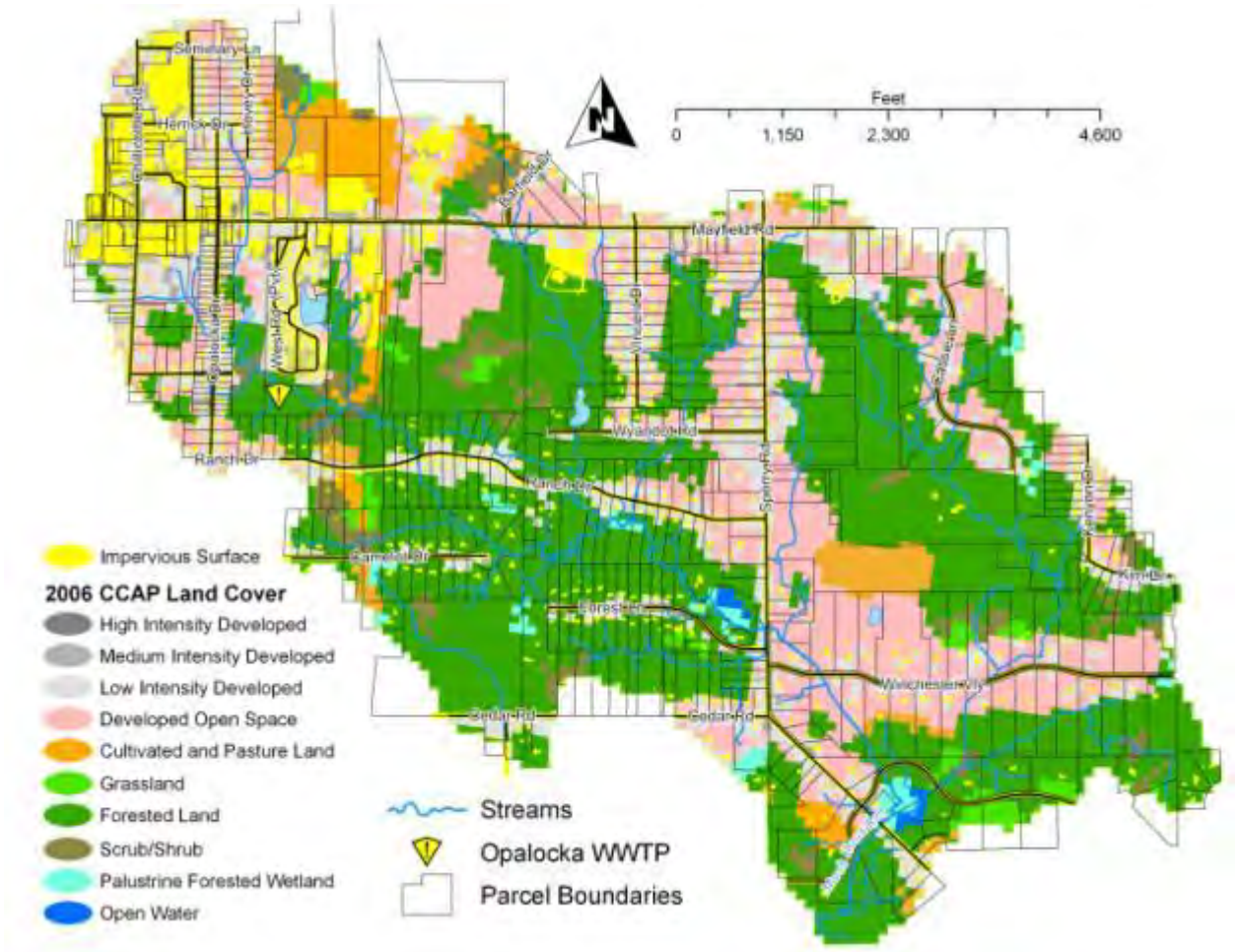


Figure 56: Land Cover in Marsh Hawk Run

Of the approximately 524 residential parcels located in the watershed, 391 (comprising 54.2% of the watershed's acreage) are built-out to the underlying zoning. Of the remaining 133 residential parcels, 52 (comprising 29.7% of the watershed) have streams on the property and have potential for future

preservation. Approximately 6.18 acres (0.4%) of the watershed is established as Township Park, a recreational park owned by Chester Township. As of 2013, no property in the watershed is protected by conservation easement or as passive parkland. The northwestern portion of the subwatershed along Chillicothe and Mayfield Roads comprises the commercial, industrial, and shopping center districts.

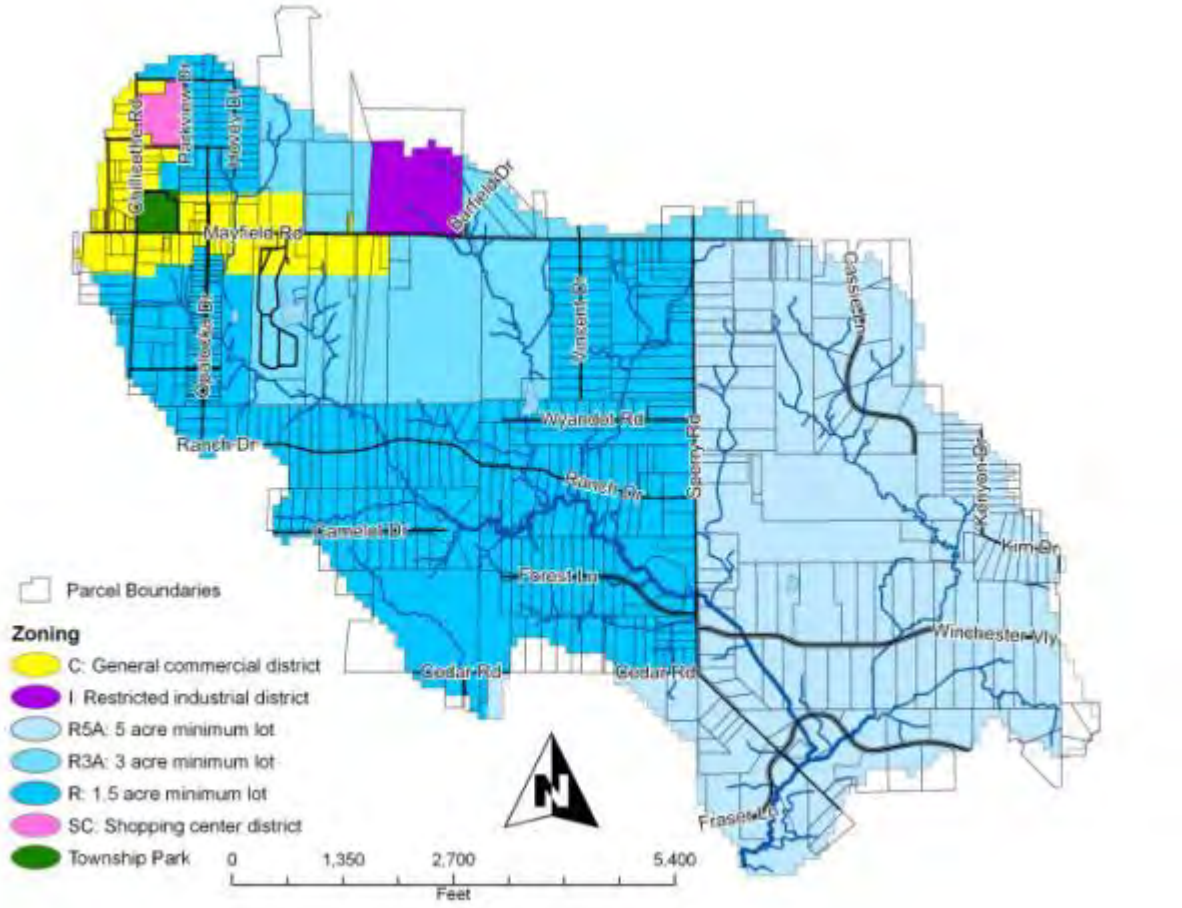


Figure 57: Zoning in Marsh Hawk Run

Several in-line ponds exist in the watershed. The largest is 1.8 acres and is located in the Maywood Park community on a small tributary that joins Marsh Hawk Run just downstream of the Opalocka Waste Water Treatment Plant (WWTP). Another is 1.2 acres and is located on a tributary that crosses Wyandot Road; a third is 0.3 acres and on a tributary that runs parallel of Opalocka Drive to the east, upstream of the Opalocka WWTP.

There are approximately 390 household sewage treatment systems (HSTS) in this subwatershed. The older, smaller-lot residences along Forest Lane, Ranch Drive, and Wyandot Road may have aging systems. Most of the soils in the watershed are naturally poorly-drained and severely limit the treatment capabilities for HSTS. The Geauga County Health District acts on complaints and conducts a point-of-sale inspection program that protects home purchasers and the community from failures of HSTS. CRWP will work with Geauga County Health District to obtain records to determine the ages of the HSTSs in Marsh Hawk Run and any sampling that may have resulted from complaints regarding HSTS.

Stormwater management is a primary concern in Chester Township's Town Center because a high percentage (65%) of impervious surface contributes to flashy flows during rainfall events. Most of this

part of the subwatershed is already at build-out, thus stormwater retrofitting and management of surface runoff is a primary goal in this area. CRWP assisted Chester Township with a Surface Water Improvement Fund grant from Ohio EPA to retrofit their Town Hall parking lot with pervious pavers and bioretention cells. In addition, a stormwater retention area was constructed along a headwater tributary to Marsh Hawk Run east of Opalocka Drive in early 2009 that mitigates the stormwater runoff from buildings and pavement located directly at the intersection of Chillicothe Road and Mayfield Road. Any future re-development in Chester Township should implement stormwater BMPs such as porous pavers, bioswales, and bioretention areas. Some businesses have already installed stormwater best management practices (Figure 58), and CRWP will continue to work with and provide technical assistance to both Chester Township and other local businesses looking to do the same.

Figure 58: Permeable Pavers at 8555 Mayfield Road, Chester Township

An impounded lake is located on the Maywood Park property that is mowed to the edges and may be chemically controlled for algae. Installation of an aeration system could be an effective solution to reduce the need to combat algal blooms with chemical applications of herbicides or dyes like AquaShade.

Opalocka WWTP

The Opalocka WWTP (8671 Cottrell Drive) services most of the commercially developed parcels in Chester Township and the residential areas along Cottrell, Opalocka, Harnick, and Hovey Drives and discharges to Marsh Hawk Run as the stream flows south of the Maywood Mobile Home Park property, and. Improvements in 2011 replaced old filters with a new hydroclear sand filter, added a digester tank, and converted the old digester into an equalization tank.

Wyandot Road, Ranch Drive, Forest Lane, Camelot Drive, and Vincent Drive

Figure 59: Impounded lake on Wyandot Road

Figure 60: Scour pool at culvert downstream of Wyandot Road

Downstream of the Opalocka WWTP, Marsh Hawk Run flows southeast through older residential neighborhoods built mainly in the 1950s and 1960s with an average lot size of 1.5 acres. These properties, located along Vincent Drive, Wyandot Road, Ranch Drive, Camelot Drive, and Forest Lane have good riparian tree cover along the streams and most of the lots are wooded; however, an in-line 1.2 acre lake is located on Wyandot Road (Figure 60) that is mown to the edges. Downstream of the

impoundment on the south side of Wyandot Road was a clearly visible scour pool at the culvert outfall (Figure 61). Moderately embedded substrate was visible in the scour pool and immediately downstream of the culvert.

Figure 61: Wetland, Ranch Drive

Figure 62: Heavy vegetation downstream of culvert, Ranch Drive

Heavy vegetative cover was common along the stream crossings on Ranch Drive. The water exiting the downstream culvert on an unnamed tributary to Marsh Hawk Run at RM 1.33 appeared cloudy. Debris blocked a portion of the culvert on the upstream side. An adjacent wetland located immediately to the west of the tributary on the upstream side (Figure 62) may function as flood storage on Ranch Drive. This area is serviced by HSTS. Approximately 200 feet upstream of the culvert crossing, the tributary appears to be straightened with riparian vegetation removed and portions enclosed in pipes before transitioning into a forested area. Downstream of the culvert crossing the vegetative cover is very heavy (Figure 63) and continues downstream to where the stream joins Marsh Hawk Run.

Figure 63: Debris blocking culvert upstream of Ranch Drive

Figure 64: Downstream of culvert on Ranch Drive

Debris blocked one of the two culverts where an unnamed tributary to Marsh Hawk Run at RM 1.43 crosses Ranch Drive. This debris could inhibit flow through the culvert, causing water to back up and flood the banks during high flow events and could lead to flooding on Ranch Drive. The upstream side has minor grassy vegetative cover on the banks and is channelized through the residential property. Downstream of the culvert, vegetative cover was well-established with sufficient trees providing shade, but bank erosion and exposed roots were observed along the side where the unblocked culvert was located. The stream substrate was slightly embedded with fine silt, but included a good mix of boulder, cobble, and gravel.

Figure 65: Straightened stream at culvert, Ranch Drive

A concrete-reinforced piped culvert (above) was located where an unnamed tributary to Marsh Hawk Run at RM 2.05 crosses Ranch Drive. The substrate had minimal embeddedness with cobble and gravel being the dominant substrates. The stream was well-shaded but has been straightened. The downstream section was not visible from the roadway; it looks to be buried for about one hundred and fifty (150) feet in the adjacent residential property and appears to emerge in a forested area.

From Sperry Road west to where Marsh Hawk Run crosses Ranch Drive, the riparian corridor was forested through residential lots, but these residential lots are old, fairly small and treat sewage with HSTS. Nutrient input from failed HSTS may be a water quality issue in this portion of the watershed.

Figure 66: Upstream of Sperry Road

Figure 67: Bank erosion and fallen tree downstream of Sperry Road

Good in-stream channel development with varied substrates can be seen upstream of the Sperry Road culvert (Figure 67). Bank erosion and a fallen tree were observed immediately downstream of the culvert, but the channel appeared to re-stabilize about 150 feet downstream. Overall the channel had good vegetative cover and stream shading. The upstream segment receives drainage from an adjacent road ditch that runs parallel to Sperry Road and joins with a minor tributary. Further upstream the channel runs alongside an approximately 4-acre lake that was initially an on-line impoundment, but was modified in 1998 to an off-line lake by restoring the stream channel to its original location to eliminate concerns regarding ODNR dam regulations. While the downstream channel exhibits good vegetative cover at this immediate location, it is joined by an unnamed tributary at RM 0.83 that is impacted from channel straightening, lack of riparian vegetation, and potential HSTS inputs. This unnamed tributary could be a primary source of nutrient and sediment stressors to the non-attaining reaches further downstream.

Two small headwater tributaries with heavy forest cover flow south through low-density residential development on either side of Cassie Lane. Bank erosion was observed immediately downstream of the culvert at the road crossing. A small (0.125 acre) pond is located on the eastern tributary upstream from the crossing that takes diverted flow from the tributary. The homes along this street have sale dates mainly in the past ten years so failing or aged on lot septic systems may not be an immediate concern. The tributary that runs parallel to the west of Cassie Lane has been channelized and enclosed as it crosses through several residential properties.

Figure 68: Downstream of Winchester Valley

Figure 69: Upstream of Winchester Valley

A covered bridge is located on Marsh Hawk Run at RM 0.73 as it crosses Winchester Valley. Gravel and sandbar development were observed upstream and downstream of the culverts and bridge, and small fish were observed in the pool located at the upstream culvert mouths. A third culvert to the west of the bridge carries additional flow under the road to a small vegetated ditch, which outlets into the stream on the south side of the bridge (Figure 70). Moderate to heavy embeddedness was observed in the substrate immediately around the culverts. Downstream of the culverts, minimal riparian buffer is established before transitioning to a more heavily wooded area with relatively good floodplain connectivity (Figure 69). CRWP staff made a site visit to this location on November 3, 2008 and observed sediment buildup in both culverts potentially reducing flow capacity through the culverts. During a 2008 and 2011 site visits the stream bank was stable with good vegetation established. This area was dredged by the Chester Township Road Department and a private excavation company in the spring of 2009 to remove accumulated gravel and sediment. The gravel and sandbars re-formed after the next major rain event and have not been dredged since.

Figure 70: Stream modification downstream of Winchester Valley

Figure 71: Stream modification upstream of Winchester Valley

Lack of riparian cover and extreme modification was observed at an unnamed tributary to Marsh Hawk Run at RM 0.10 as it crosses Winchester Valley Drive. The stream flows out of a heavily forested area and through low riparian cover and several 5-acre residential properties for approximately 1,165 linear feet until it enters the culvert at Winchester Valley Drive. Downstream of the culvert at Winchester Valley Drive approximately 490 linear feet of this unnamed tributary is straightened and mowed to the edge before it transitions into a forested wetland area. Some buffer vegetation is in place on the upstream side where one of the landowners has eliminated a small in-line pond and created a small rain garden at the point where the stream exits a culvert under their driveway. Improving this stretch of stream through reestablishment of sinuosity and riparian vegetation may help improve the quality of water flowing further downstream into the non-attaining segment of Marsh Hawk Run.

Marsh Hawk Run and two headwater tributaries cross Marsh Hawk Run Road. Substrate in this area is highly embeddeded. Flow exiting the culvert on the downstream side was significantly higher than the flow entering which may indicate debris blockage inside the culvert. This is also one of the flattest locations in the watershed which contributes to sluggish flow and subsequent siltation in this area.

An unnamed tributary to Marsh Hawk Run at RM 0.37 flows through a large, approximately 13-acre wetland complex as it crosses Marsh Hawk Run Road. This large wetland/floodplain complex serves as a vital stormwater sink for upstream flows and could be a potential candidate for improvement and protection.

Downstream of this wetland complex, Marsh Hawk Run enters a culvert under Sperry Road and flows parallel to Fraser Lane through a low-density (minimum 5-acre lot) residential development for approximately 1,800 linear feet before it joins the Chagrin River mainstem. The riparian corridor is heavily forested through most of the residential lots, providing shading and riparian cover throughout this reach. What stream was visible through the woods appeared to be in good condition.

In 2004, Ohio EPA sampled Marsh Hawk Run on RM 0.3 near the crossing at Sperry Road for their 2006 Chagrin River TSD report and notes a tolerant fish and a fair macroinvertebrate community. The number of tolerant invertebrate species was considerably higher than sensitive species, which Ohio EPA attributes

higher numbers of tolerant invertebrate species to impacts from suburban residential development and nutrient inputs. Chemical sampling downstream of the Opalocka WWTP showed elevated levels of Nitrate-nitrite and phosphorous. All chemical parameters were within WWH criteria levels; however, nutrient enrichment, ammonia toxicity, and siltation are all noted as potential chemical stressors on the biological communities. Septic discharge was also noted as a stressor in the study reach. Ohio EPA designated this stream as WWH and determined this tributary to be in non-attainment of its WWH use designation due to excessive nutrients, organic enrichment, and low dissolved oxygen.

The primary physical stressors are listed in the 2006 TSD as increased runoff from impervious surfaces in Chester Township, channelization, and removal of riparian vegetation from development. Additional stressors include nutrient enrichment from HSTSs and livestock from the small farms located throughout the Marsh Hawk Run subwatershed. The lower reaches of Marsh Hawk Run appear to be a modified habitat with wetland influences and so may contribute naturally low levels of DO to the stream system, which may hinder it from achieving full WWH habitat attainment status in these areas. However, the wetland system also retains stormwater and provides nutrient filtration and habitat for migratory and native species. Since the majority of the watershed is built-out and is privately owned, working with landowners on HSTS maintenance and the importance of maintaining riparian corridor will be essential to the health of Marsh Hawk Run. Preservation of land through acquisition or easement should not be overlooked, particularly on the larger parcels along Sperry Road where farms are located.

Marsh Hawk Run is impacted by bacterial flows resulting from HSTS and possible point discharges from the Opalocka WWTP, and the area around the intersection of SR 306 and SR 322 in the upper reaches of the watershed contains 65% of the watershed's impervious surface. Runoff from impervious surfaces and discharges from the Opalocka WWTP could contribute significant levels of flashy flow to the stream system which creates bank instability and erosion further downstream.

11.4.3 Leech Tributary (RM 41.53)

Two tributaries to Dewdale Creek at Leech Tributary (RM 42.5/0.5 and RM 42.55/0.31) are designated CWH due to stocking of native brook trout by ODNR. The CWH Dewdale Creek tributaries are recommended for General High Quality Waters under the Antidegradation Rule, as they are possible refuge tributaries (streams connected to Leech Tributary via wetland) for native brook trout.

11.4.4 Dewdale Creek

Dewdale Creek drains a significant portion of Newbury Township and a small portion of Munson Township in Geauga County, and enters into the upper main branch of the Chagrin River in the Geauga Park District Rookery Park. The streambed has a low gradient and is dominated by wetland corridors and several kettle hole lakes, including Kiwanis Lake.

Impacts to Dewdale Creek have included channelization of several sections to facilitate drainage of wetland areas. Wetland streams typically do not have substrates that promote robust biological communities; however, it is Ohio EPA's opinion based on sampling that despite its historic wetland characteristics, Dewdale Creek is capable of attaining CWH aquatic life use. Sampling completed in 2004 shows non-attainment at Auburn Road caused by nutrients, possible ammonia (NH3) toxicity, organic enrichment, low dissolved oxygen, thermal modification from suburban NPS stormwater runoff inputs, onsite septic or HSTS inputs, and removal of riparian vegetation. The downstream portion of the creek at Rockhaven Road is in full attainment of CWH. Ohio EPA recommended Dewdale Creek for Superior High Quality (SHQ) under the Antidegradation Rule based on its biotic diversity, high biological scores at Rockhaven Road, and its probable function as a refuge and migration route for native brook trout.

The Dewdale Creek subwatershed drains 13 square miles of land comprised of 6% impervious area, 37% wooded area, 41% agricultural and open areas, 6% non-forested wetlands, and 10% scrub/shrub area as shown in Figure 24. Figure 72 shows the open space and protected areas located within the subwatershed. Seven percent of the Dewdale subwatershed is currently protected through parks and conservation areas.

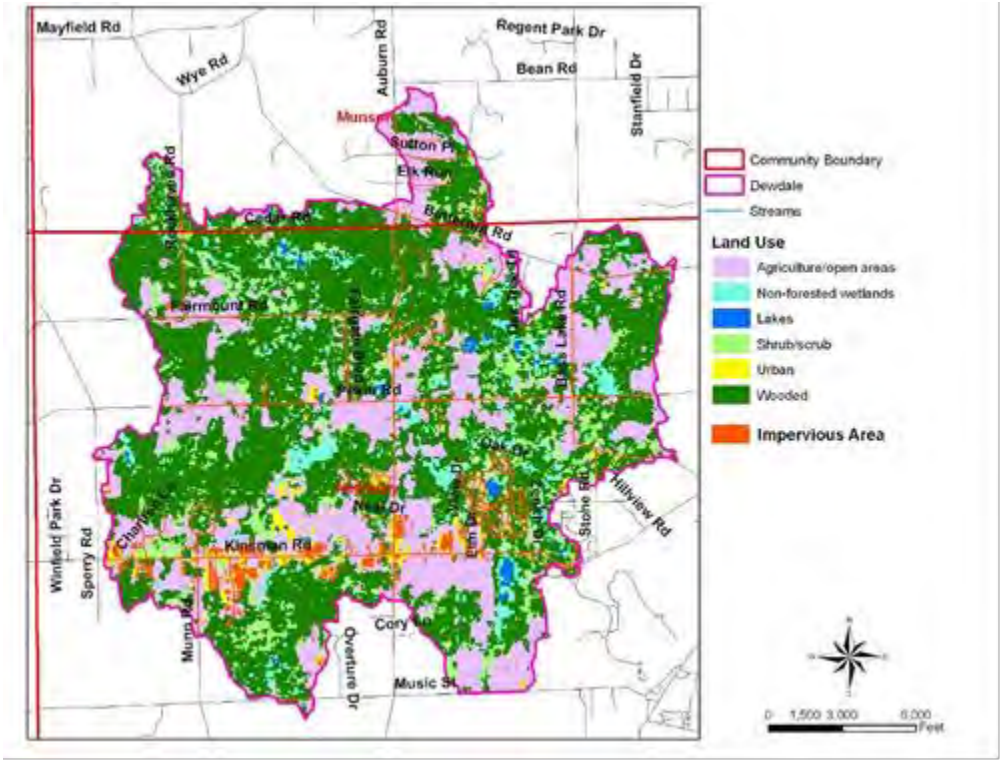


Figure 72: Land Use in Dewdale Creek Subwatershed.

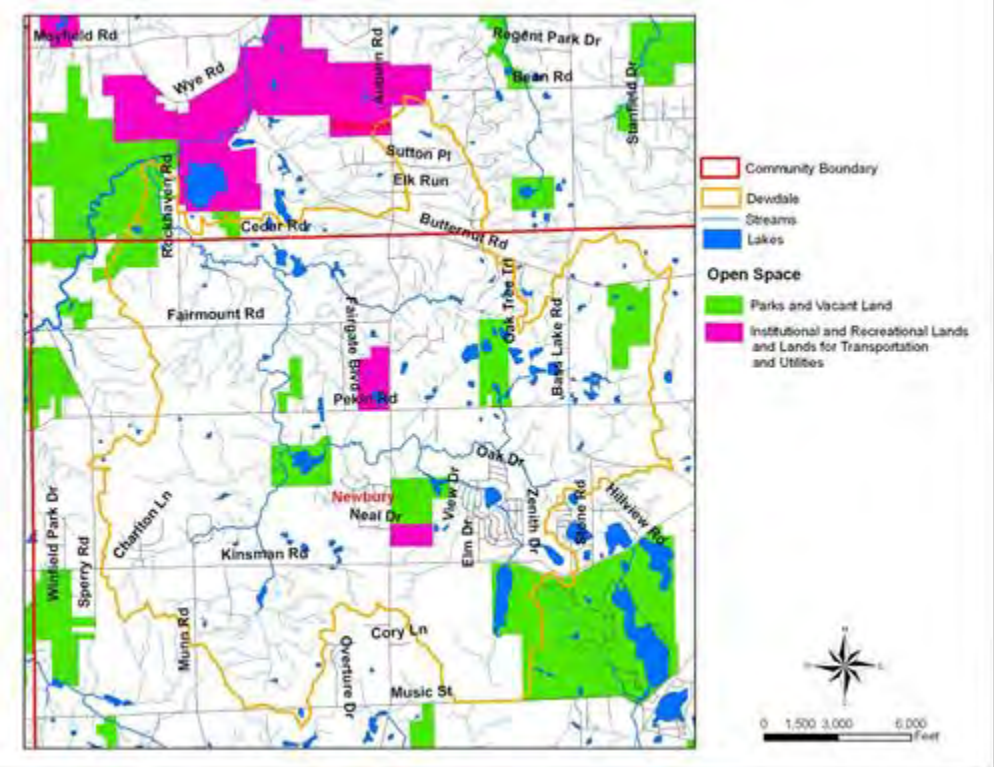


Figure 73: Protected Lands in Dewdale Creek Subwatershed.

Newbury and Munson Townships participated in the *Chagrin River Watershed Balanced Growth Plan* by identifying priority conservation areas (PCAs) and priority development areas (PDAs) for their community and endorsed their PCA and PDA maps, as shown in Figure 74. The two primary PDAs were at the intersection of S.R. 87 and Auburn Road and at the intersection of S.R. 44 and S.R. 87. Kent State University Urban Design Center drafted conceptual plans for the development at S.R. 87 and Auburn Road. PCAs include riparian corridors and existing parks and conservation easements, as well as large parcels that may be possible open space or future conservation easements, or that could be developed using conservation development.

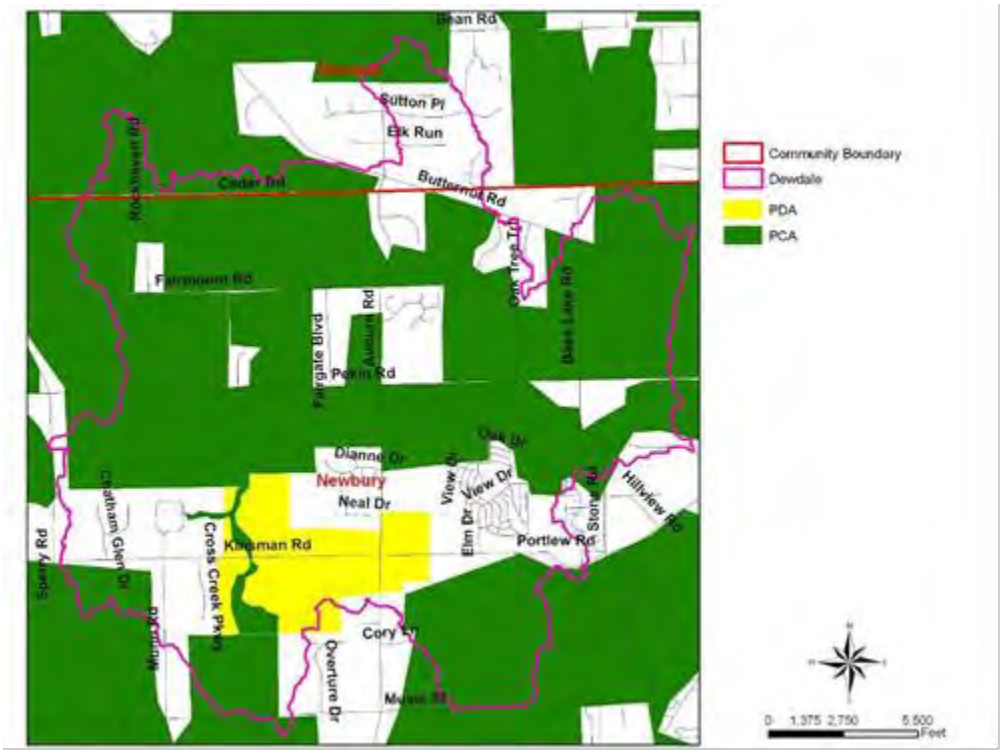


Figure 74: PCAs and PDAs in Dewdale Creek.

There are approximately 1,063 HSTS and 10 small WWTP's located within this subwatershed. CRWP has begun discussions with and will continue to work with the Geauga County Health Department to obtain records of known HSTSs, specifically upstream of Fairmount Road, in order to determine the age of the HSTS and whether any sampling may have resulted from complaints regarding sanitary sewage. Due to the age of the development in this area, many of the HSTS are likely failing and need to be replaced. In August 2010, a tributary to Kiwanis Lake showed obvious grey water indicating a failing HSTS and resulting sewage discharge.

In 2003 and 2004, Ohio EPA sampled Dewdale Creek at two upstream locations; the crossing under Auburn Road at River Mile (RM) 4.6 and near the mouth at Rockhaven Road at RM 0.6. At RM 4.6 the stream is in non-attainment; however, by RM 0.6 it has recovered and meets full attainment. Dewdale Creek is spring-fed with some wetland attributes and has good instream channel development. The creek benefits from a predominantly wooded riparian corridor that is mostly intact and its streambed is composed of varied substrates. In 2003, low dissolved oxygen was observed in Dewdale Creek, likely due to large wetland complexes and failing HSTS. The RM 4.6 site has some removal of riparian vegetation and is impacted by nutrient loading (including NH_3) from upstream septic and suburban nonpoint source stormwater runoff. These impacts lower instream dissolved oxygen concentrations and alter the thermal regime by increasing water temperatures. Other observations include elevated bacteria levels at RM 0.6, lower pH at RM 4.6, and elevated phosphorous at RM 2.6.

Fish communities in Dewdale Creek marginally meet WWH criteria, mostly because Dewdale Creek is a wetland stream at Auburn Road. Ohio EPA, recognizing this area to be a modified pool habitat with wetland influences, noted the macroinvertebrate community was not very diverse. Overall, though, Dewdale Creek has good instream channel development and varied substrates. The downstream portion of Dewdale Creek has exceptional macroinvertebrate community quality with 26 total EPT taxa and 44 sensitive taxa, including five coldwater taxa.

CRWP staff has visited a number of sites within the Dewdale Creek watershed. In April 2010, CRWP staff completed a windshield survey of the watershed with photo locations at all major stream crossings. Below is a pictorial summary of the subwatershed, with CRWP recommendations based upon these observations.

The furthest upstream section of the subwatershed is Pine Lake, just west of Punderson State Park. Pine Lake and another lake just north of S.R. 87 (shown on left below) both drain down to Kiwanis Lake (right). Kiwanis Lake was historically a cottage community and still contains small lots with several platted streets that were never constructed. The streams draining to Kiwanis Lake are primary headwater streams and have not yet been assessed. Kiwanis Lake is surrounded by open space owned by the Kenston Lake Homeowners Association. This open space contains significant shrub/scrub wetlands. Kiwanis Lake, an 80-foot deep kettle lake, serves as one of the primary sources of water for the nearby wetlands. A nearby spring could also contribute water to the streams, wetlands, and Kiwanis Lake. At this time the wetlands are assumed to be high quality Category 3 wetlands, but they are impacted by invasive buckthorn (*Rhamnus*) populations and control of these invasive plants is recommended.

Downstream of Kiwanis Lake is another large wetland complex, approximately half of which is owned by the Newbury Township Trustees. The wetlands and associated streams have a tributary drainage area of 1.8 square miles. The wetland soils are composed entirely of Wallkill silt loam; a deep, very poorly-drained soil formed along streams and in bogs that is ponded much of the year and is poorly suited to any land use besides wetland habitat. The aquatic habitat is made up of shrub and emergent plant communities with a large forested buffer. Outside of the forested buffer, adjacent land uses include large lot residential, the Kiwanis Lake Subdivision, and open fields. Invasive species such as *Phalaris arundiacea*, *Phragmites australis*, and *Rhamnus* are noticeably present and their management and removal is recommended.

The wetland on the Township property has been historically impacted with small impoundments (both beaver and human-made) and dredging activities along the stream with materials cast into the wetland. Despite these impacts, the wetland is still considered to be a high-quality system and is assessed at Category 3.

The tributary that flows from the south under Kinsman Road drains portions of the commercial and industrial district in Newbury Township. These streams are wetland-influenced and beaver activity is evident. In addition, numerous "package plants" (small WWTPs) service these businesses. In the location of the below photo near Bill's Auto Body, a septic odor was strong and Bill noted that his septic system constantly discharges due to a spring in the area. These impacts could be causing significant loading of bacteria and nutrients to the stream.

Immediately downstream of Fairmount Road, much of the riparian vegetation on the left side of the stream has been removed and erosion along the bank is evident. This area is recommended for supplemental riparian plantings.

Continuing downstream of Fairmount Road, a tributary enters the main channel of Dewdale Creek from the east. This tributary is in a completely wooded corridor except in the location of the Swetland ponds (as named in ODNR's dam database). These ponds could be investigated for future removal or adaptation, as open water can create significant thermal impacts in a coldwater habitat stream. Otherwise this tributary is a good candidate for preservation as most of the wooded riparian corridor and associated wetland complexes are intact. The stream is in full attainment of CWH status near the mouth at Rockhaven Road in Munson Township. The photo below shows some of the wooded and wetland corridor evident throughout the lower reaches.

11.4.5 Ecklund Tributary (RM 46.20)

Ohio EPA designated this stream as CWH due to native brook trout reintroduction.

11.4.6 Bass Lake

Bass Lake is a glacial lake created over 10,000 years ago that has been modified by a placement of a dam at the lake outlet. Today the lake is very shallow, with an average depth of approximately 5 feet with a maximum depth of 9.5 feet. Much of the lake has a diverse wetland community. A low dam structure allows for lake water levels to be raised or lowered to meet multiple lake management needs, but also acts to trap sediment. The amount of sediment that has accumulated over time is unknown, but is expected to be substantial. Bass Lake fluctuates seasonally between eutrophic (nutrient enriched, high primary production) and hypereutrophic (highly enriched) in response to changing levels of total phosphorus in the water column. Both internal (lake sediment) and external (point sources, tributary streams) sources of nutrients influence the water quality of Bass Lake, but their relative contributions are currently unknown.

Low and moderate residential development in the upper portion in and around the Bass Lake area has changed runoff characteristics and quality. Loss of wetlands due to filling has also occurred in the past in this important headwater area although the rate of loss has probably lessened in recent years. No data is available to assess the amount of wetlands acres lost in this area. Removal of riparian vegetation and modifications to headwater streams are also significant problems along selected tributaries. Finally, onsite wastewater discharges (leachate) to Bass Lake are a major problem and an important cause of nitrification problems occurring in this important headwater water body.

In 2002, Ohio EPA performed a study to provide baseline data on the existing conditions and to assist in the development of a long-term comprehensive management plan for Bass Lake and its associated wetlands. Results of the sampling efforts indicated that any future considerations of the phosphorus levels in Bass Lake must consider the reservoir of phosphorus in the lake bed sediments and surrounding wetlands. Electro-fishing data indicated a stressed fish community exhibited by low number of fish collected and the high percentage (3.5%) of DELT anomalies (deformities, eroded fins, lesions, tumors). Future management options must consider the low dissolved oxygen and the relatively shallow depths. Currently shallow depths and minimal amounts of deep open water do not allow a viable motorized boating and fisheries. Motorized boating and recreational fishing opportunities should be minimized unless the lake depth is significantly increased. Canoeing and kayaking may still be viable recreational opportunities. One viable management option discussed in the study was to allow Bass Lake to progress naturally via succession into a shallow wetland-open water complex. Finally the study recommended several further research projects that may help determine appropriate management options in the future. Bass Lake Management Strategies that decrease nutrient concentrations, NPS inputs, and increase dissolved oxygen concentrations could positively affect the water quality in the Chagrin River downstream from the outlet. Ohio EPA recommended that the Geauga County Health Department investigate fecal bacterial sources in this area.

11.4.7 Springbrook (RM 47.65)

This small coldwater stream drains into Bass Lake and supports native Ohio Brook Trout. ODNR has worked to establish populations of native brook trout elsewhere in the watershed using fish secured from Springbrook. Ohio EPA is recommending CWH use designation.

11.4.8 Woodiebrook (48.30)

Woodiebrook was severely impacted by development when an impoundment was created along one fork and another channel was relocated in the late 1980's. River restoration completed by Oxbow River and Stream Restoration constructed 3,260 linear feet of an "E" type channel, complete with riffle/pool structures, undercut banks and spawning beds. The riparian area was revegetated and the corridor has been placed under a permanent conservation easement by WRLC. Restoration work began in October 2000 and was completed by June 2001. ODNR stocked the stream with Ohio Brook Trout in April 2001.

The restoration has been a success and native Ohio Brook Trout are growing in their restored habitat. Ohio EPA is recommending CWH use designation.

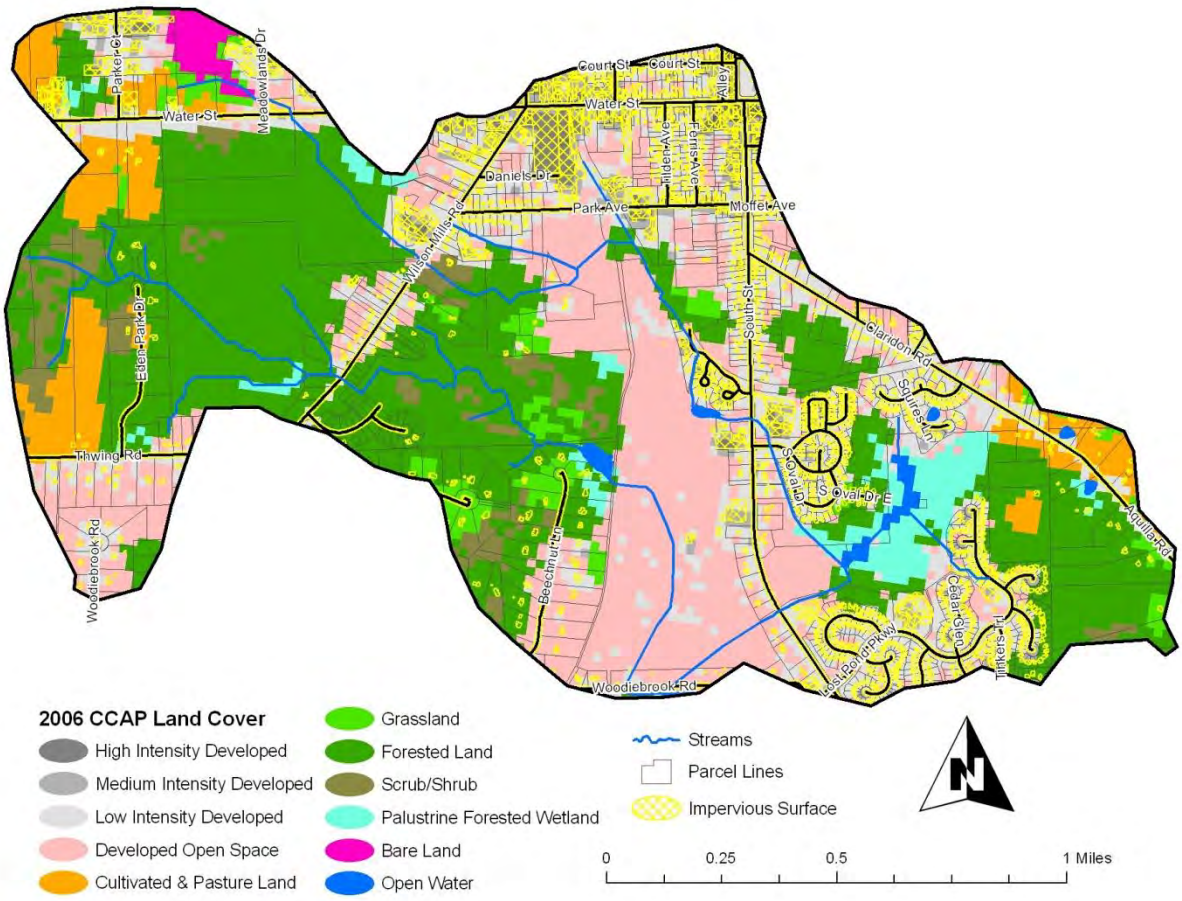
11.4.9 Beaver Creek (RM 47.40)

This stream is designated as a coldwater stream. The lower 1.0 mile of this stream near Bass Lake has been channelized in the past. In 1995, Ohio EPA sampling stated that Beaver Creek was in full attainment of CWH status. However, Ohio EPA changed the aquatic life use designation of this section to WWH in 2005. Development is a significant threat in this subwatershed. Both CWH and WWH portions of this stream are in full attainment. Sampling in 2003/2004 indicated high ICI scores and good diversity of cold water organisms. Ohio EPA also noted that lower phosphorus levels should be present downstream of the Heather Hills Hospital WWTP after upgrades and further sampling should determine effects of these reductions on Beaver Creek and Bass Lake.

11.4.10 Chagrin River upstream of Woodiebrook Road (RM 49.2)

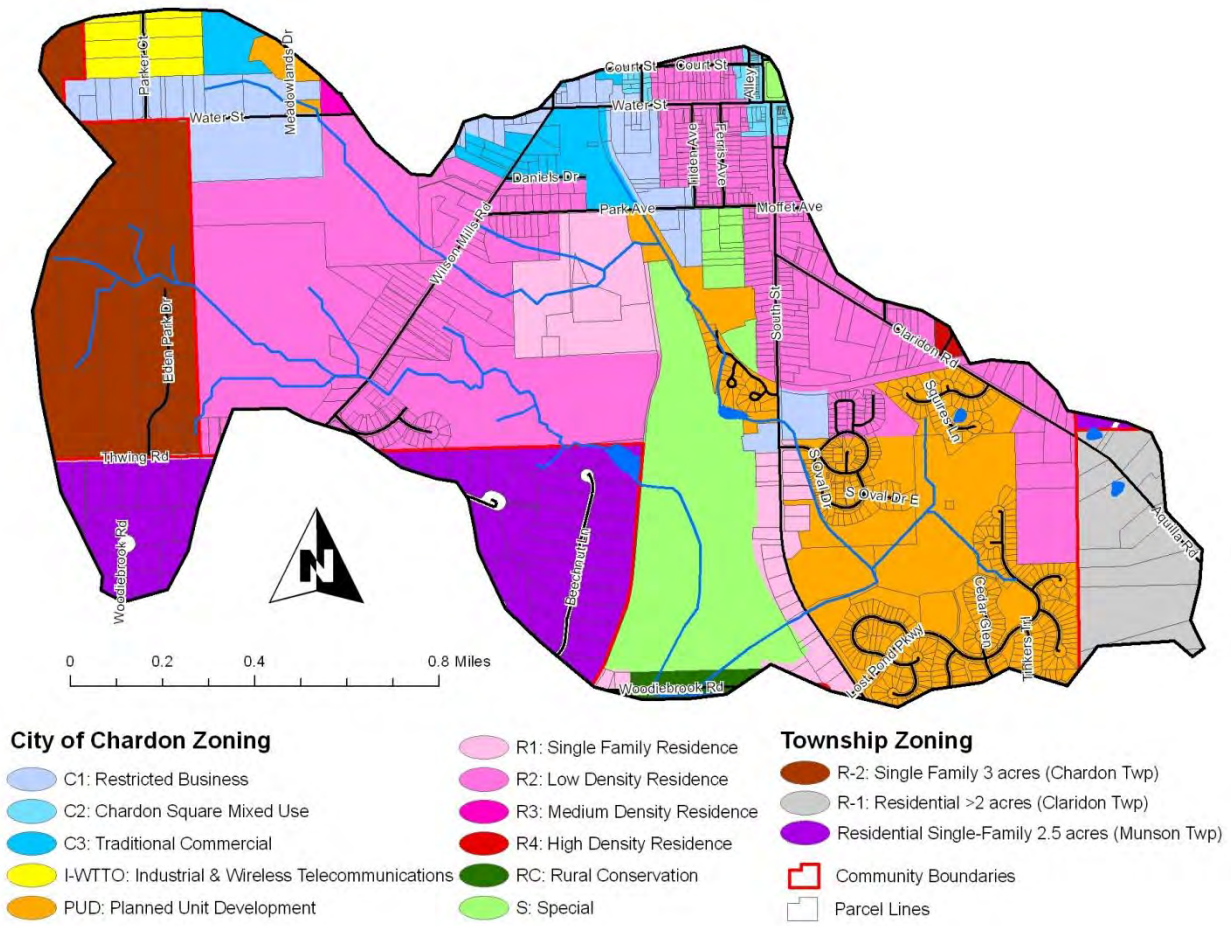
This subwatershed contains the headwaters of the Chagrin River main stem, which begin in the City of Chardon and flow south to Woodiebrook Road at RM 49.2. It drains approximately 1,482 acres and is located primarily within the City of Chardon but includes portions of Munson Township, Chardon Township, and Claridon Township.

The subwatershed is approximately 14% impervious surface, located mainly along South Street in the Woods of Burlington, Burlington Green, and Burlington Oval developments, between Park Avenue and Court Street, and along Meadowlands Drive and Parker Court north of Water Street in the City of Chardon. The land cover in the watershed is 1.34% high-intensity developed, 4.57% medium-intensity developed, 23.1% low-intensity developed, 21.9% developed open space (mowed and maintained areas), 2.9% grasslands, 35.9% forested land, 5.7% agricultural and pasture land, 3.2% forested wetlands, and 3.5% shrub/scrub area distributed as shown in the following figures.



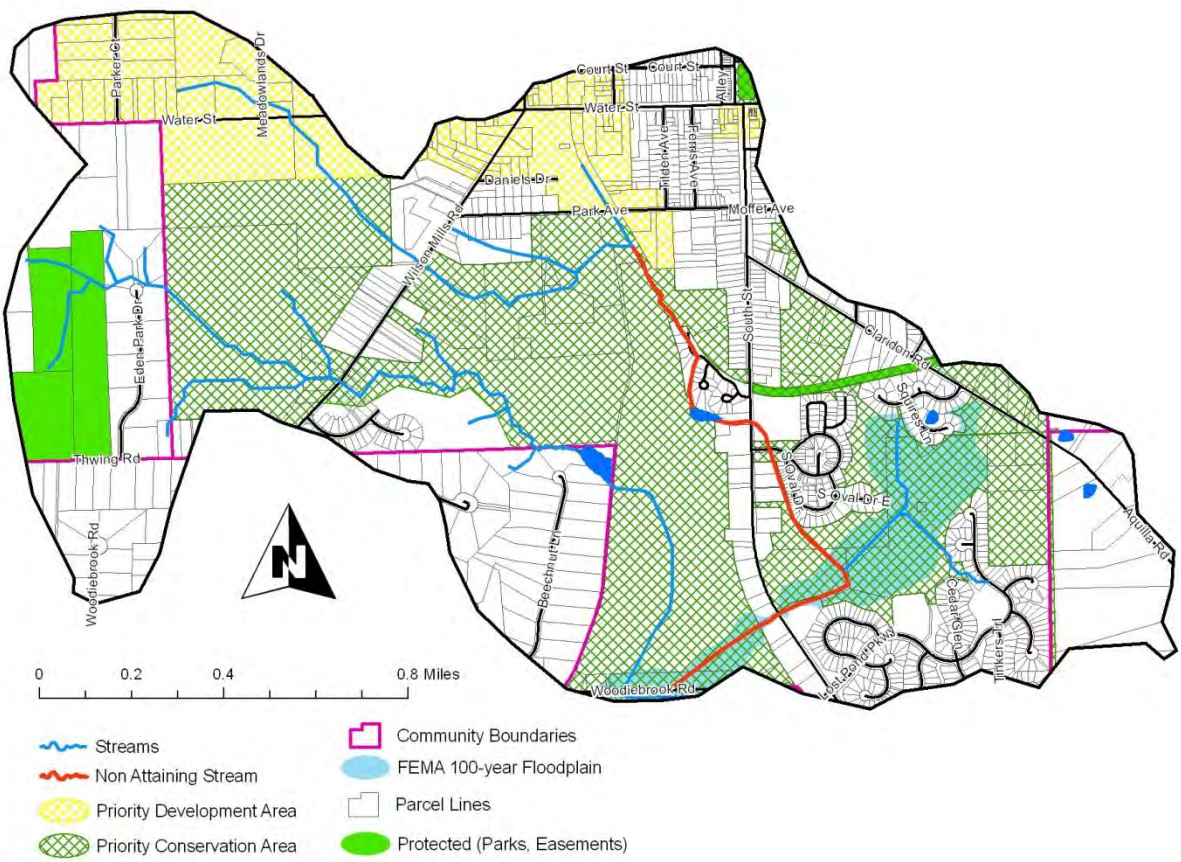
Land cover in the subwatershed.

Most of the commercially-zoned areas and the high-density and medium-density zoned areas in the City of Chardon are built-out in the subwatershed, as are most of the relevant parcels within Munson Township, which has a 2.5 minimum acre lot size zoning. However, the low-density residential areas in Claridon and Chardon Township and along Wilson Mills Road and Claridon Road in the City of Chardon are not at build-out and many opportunities still exist in the subwatershed for open space preservation.



Zoning within the subwatershed.

A total of 63.38 acres, or 4.3% of the subwatershed, is under permanent protection. The Cleveland Museum of Natural History maintains the Soubusta Sugarbush property, a 54.22 acre natural area preserve in Chardon Township. Geauga Park District maintains approximately 3.14 acres of the Bass Lake Preserve along Woodiebrook Road and 4.59 acres of the Maple Highlands Central Trail along South Street. The City of Chardon is examining ways to connect the Maple Highlands Trail from its northern end at Fifth Avenue to its southern access point at South Street, and in 2011 received a NOACA Transportation Enhancement grant to help design and partially complete a section of the Trail. This project offers an opportunity for land preservation and stream restoration, as land acquisitions by the City will be necessary to complete the trailway and approximately 2,300 linear feet (LF) of Chagrin River headwaters is contained in the proposed trailway area. The remaining 1.43 acres consist of Chardon Square Park, an active municipal park in the City of Chardon.



Protected Lands, 100-year Floodplain, and Priority Conservation and Development Areas.

While not under permanent protection, it is worth noting that Chardon Lakes Golf Course comprises about 133.3 acres, or 9% of the subwatershed, and contains nearly 3,500 LF of Chagrin River headwaters and tributaries, 855 LF of which are in non attainment. Working with Chardon Lakes grounds staff on stream restoration opportunities and encouraging more natural methods of grounds management could be an effective way to improve stream quality in this subwatershed. An opportunity for open space and wetland preservation is about 73.5 acres of vacant residential property maintained as open space in the Woods of Burlington and Burlington Oval subdivisions. These parcels contain over 3,000 LF of non attaining stream and a large forested, possibly high-quality wetland complex. A significant portion of these Burlington parcels also lie within the FEMA Special Flood Hazard Area (100-year floodplain), thereby making any further development in these areas undesirable.

Based on 2003-2004 Ohio EPA sampling, RM 49.2 upstream of Woodiebrook Road to the headwaters is in non attainment of its warmwater habitat (WWH) aquatic life use. The causes of non attainment are habitat alteration and flow alteration. Sources of these habitat and flow alterations are loss of riparian vegetation, draining of wetlands, and channelization. These habitat modifications were partially to drain wetlands and control water retention to utilize land for development.

The extreme headwaters of the Chagrin River main stem have been extensively channelized upstream from Woodiebrook Road through Chardon Lakes Golf Course, the Burlington Oval and the Burlington Green subdivisions, and have connection with a large forested wetland complex in the Woods of

Burlington subdivision. Low levels of dissolved oxygen (<4.0 mg/l) were recorded in the channelized portions of the Chagrin River main stem at locations upstream from Bass Lake. This wetland complex may be a source of low dissolved oxygen, which is listed as a cause of chemical non-attainment in this area.

Land development and historic channelization to drain wetlands have resulted in heavy loss of riparian areas and stream habitat in this subwatershed, primarily along the South Street corridor to Woodiebrook Road. Habitat restoration is likely needed to restore the aquatic life use to this reach. Stream substrates are comprised of silt with high levels of embedded substrates. The stream has low flow and little channel development, with few pool/riffle sequences. The segment of stream at Woodiebrook Road scored a 23 on the QHEI, which is significantly below the score of 60 needed for it to attain WWH standards. Modified pooled habitats and wetland influenced stream conditions limit the aquatic insect community diversity, yielding few high quality and sensitive species. Fish communities in this area were degraded by direct channelization and removal of riparian habitat.

Ohio EPA chemical tests conducted at the Woodiebrook Road site (RM 49.2) in 2002 and 2003 indicate a groundwater-influenced stream with detectable calcium, potassium, and chloride levels (likely from road salt contamination) and low nutrients.

In February 2012, CRWP staff did a preliminary survey of portions of this subwatershed within the City of Chardon, where the stream is in non attainment. Below is a summary of the observations made and CRWP recommendations based on these observations.

Headwaters to Park Street
The headwaters of the Chagrin main stem in this segment are heavily channelized and modified and flow through medium to high intensity commercially developed areas. Portions of the channel are open and ditched between Arby's and Haueter's Lawn and Sport Center, but is then buried for about 245 feet until the stream emerges from a culvert adjacent to a large commercial plaza at 425 Water Street (see below). The stream in this area exhibits low flow, silted water and highly embedded substrate. Drainage pipes from the adjacent commercial plaza route stormwater directly into the stream.

Headwaters of the Chagrin River, showing culvert and drainage pipes behind large commercial plaza.

Downstream of the culvert, the stream remains highly channelized. The banks are vegetated with tall grasses and woody shrubs. This section of the stream follows an old CSX rail line and was likely ditched

or straightened to accommodate the railway. The rail line is no longer operational and any tracks have been removed. The parcel to the west of the stream is vacant commercial property.

Looking upstream (north) towards the commercial plaza and culvert.

East of the stream are several parcels owned by the City of Chardon. These parcels used to house the City's salt storage and service garage, which caught on fire in March 2008. A new City service complex is slated to be built at 501 North Hambden Street. A large shed on the property is still used as salt storage by Chardon Schools. Surface runoff from this shed drains directly to the stream.

Salt from storage shed draining down towards the stream.

Park Avenue to Burlington Green Subdivision

The stream is culverted under Park Avenue and enters the Hidden Glen property, a privately-owned parcel zoned for Planned Unit Development. A small tributary flowing from the west through the 50-acre Sanborn property joins the main stem here as well. This tributary flows through a wooded corridor and may be piped as it crosses a 17-acre open mowed area before joining the main stem. These large parcels could be targeted for protection through conservation easement and eventual restoration of the stream.

After entering the Hidden Glen property, the stream then flows south for about 1,488 feet along what was once CSX rail corridor, between forested commercial property and Chardon Lakes Golf Course. The Hidden Glen property is currently undeveloped and exists in an open meadow state. From aerial photos, the stream appears to exhibit some sinuosity through this segment, but private access issues prevented any direct stream observation. The City of Chardon owns a 3-acre parcel east of the Hidden Glen property that is being held for possible expansion of the Chardon cemetery. The parcel is undeveloped and appears to exhibit characteristics of a forested wetland. This wetland area may influence the nearby stream, contributing to low levels of dissolved oxygen.

Forested City-owned wetland area next to Chardon cemetery.

View of Hidden Glen property from Chardon cemetery, looking downstream. The house in the center distance marks the start of Burlington Green subdivision.

Burlington Green to South Street

As the stream enters Burlington Green subdivision, it exhibits deep entrenchment and channelization. It flows through the front yards of several homes in the subdivision where mowing is done to the edges of the streambank. Slumping can be seen on the slope edges here. The stream is open for about 175 feet

and is then buried in a pipe as it flows under Greenway Drive for the next 237 feet. The stream exits a culvert and flows through several residential backyards on Wynewood Place. The culvert area has been stabilized with rocks and the streambank here is vegetated with trees and shrubs for approximately 300 feet before it enters another culvert. The banks in this location up to the second culvert were entrenched but appeared stable. A CRWP site visit here in 2011 offered recommendations for daylighting the buried segment of stream at this point, as the pipe had failed and a sinkhole was developing.

Sinkhole developing at Burlington Green subdivision from failed pipe.

The stream flows east into an in-line pond created by a small dam and spillway structure between Burlington Green and Bass Lake Tavern. As the stream exits the spillway structure, it exhibits low flow velocity and there is no riparian cover. The only vegetation is turfgrass and it is mowed to the edge of the banks until it enters a large culvert under South Street. The silt cover in this area appeared moderate to heavy and the substrate looked moderately embedded.

South Street to Woodiebrook Road

The stream exits the culvert under South Street and flows through the Burlington Oval subdivision, where it is deeply entrenched, channelized, and piped as it flows under Burlington Oval Drive. Riparian cover is minimal to nonexistent and most of the streambank is mowed to the edge.

Channelized and mowed stream at Burlington Oval subdivision, north of Burlington Oval Drive.

Severe bank erosion can be seen along this section of stream at the culvert downstream of Burlington Oval Drive. The stream flows through a parcel maintained as open space between the Burlington Oval and Woods of Burlington subdivisions. This parcel consists of a large forested wetland complex and preservation of this complex through purchase or easements should be investigated.

The stream flows southwest back under South Street and into the Chardon Lakes Golf Course, where it is again heavily channelized, entrenched, and mown to the edge for the next 1,600 feet where it meets Woodiebrook Road. An unnamed tributary flows from the northwest through Chardon Lakes to join with the main stem at this point and exhibits the same hydromodification and lack of riparian cover (above).

Figure X: Section of stream as it flows through Chardon Lakes Golf Course.

The area delineated by the orange circle appears to be a large forested wetland and so may contribute naturally low levels of DO to the stream system, which may hinder this segment from achieving full WWH habitat attainment status. However, the wetland system also retains stormwater and provides nutrient filtration and habitat for migratory and native species and should be preserved and maintained in a natural state. Stream restoration is a high priority in this subwatershed, most notably along the non attaining segments that flow through the Chardon Lakes Golf Course and Hidden Glen property. Restoration is also a priority for the heavily channelized streams in the Burlington Green and Burlington Oval subdivisions, but may be difficult to accomplish based on constrained corridor size and multiple private ownerships. The Sanborn parcels should be looked at as possible conservation easement properties, and stormwater retrofits in the heavily developed commercial areas of the City of Chardon could serve to alleviate excessive stormwater flows to the stream. Although the City of Chardon is not under NPDES Phase II permitting standards, implementing Good Housekeeping standards at their municipal service facility would benefit water quality and reduce water quantity to sensitive headwater streams.

CRWP is currently assisting the City of Chardon with reviewing their Maple Highlands Trail project for possible integration of stormwater retrofits and stream restoration along the proposed trailway. CRWP will continue to encourage the Member communities in this subwatershed to participate in the Chagrin River Balanced Growth Plan and adopt and implement these regulations, which can protect water quality, reduce flooding, and provide economic savings for the community.

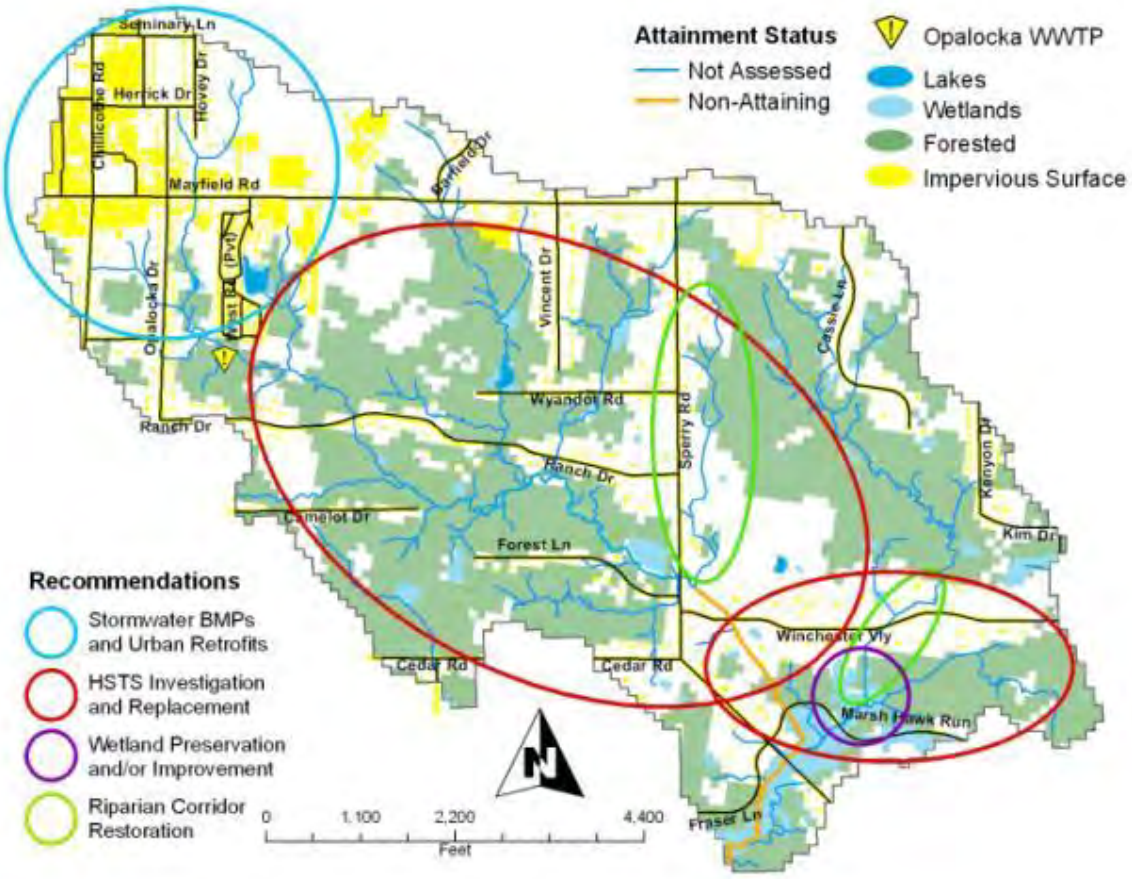
11.4.11 Summary and Recommendations

CRWP continues to work with communities on development regulations that will assist to maintain natural resources and provide comprehensive stormwater management. CRWP further recommends the adoption of the following:

- Chardon Township: Riparian and Wetland Setbacks and Conservation Development
- Chester Township: Participation in the Chagrin River Watershed Balanced Growth Plan, Riparian and Wetland Setbacks, Conservation Development, and Parking Regulations that minimize impervious surface and allow stormwater retrofits.
- Munson Township: Riparian and Wetland Setbacks and Conservation Development
- City of Chardon: Parking Regulations that minimize impervious surface and allow stormwater retrofits, Riparian and Wetland Setbacks, Conservation Development.
- Russell Township: Revise existing Planned Unit to a Conservation Development code.
- Newbury: Riparian and Wetland Setbacks and Conservation Development
- South Russell Village: Riparian and Wetland Setbacks

CRWP developed specific recommendations for the Marsh Hawk Run tributary highlighting locations for improvements and the location of non-attaining streams. CRWP makes the following recommendations for Marsh Hawk Run:

- Investigate bacterial and ammonia (NH_3) sources in upstream areas in cooperation with the Geauga County Health Department. Multiple sources of bacteria and ammonia likely include both small WWTPs and failing HSTSs.
- Complete wetland and riparian corridor restoration including tree planting and invasive removal.
- Replacement of failing HSTS, upgrade WWTPs, or centralize sewers.
- Enhance and preserve streams, wetlands, and Kiwanis Lake
- Implement stormwater retrofits in the commercial area in the upstream reaches of the Marsh Hawk Run subwatershed.



CRWP developed specific recommendations for the Marsh Hawk Run tributary highlighting locations for improvements and the location of non-attaining streams. Additional land protection along the lower reaches in attainment is highly recommended.

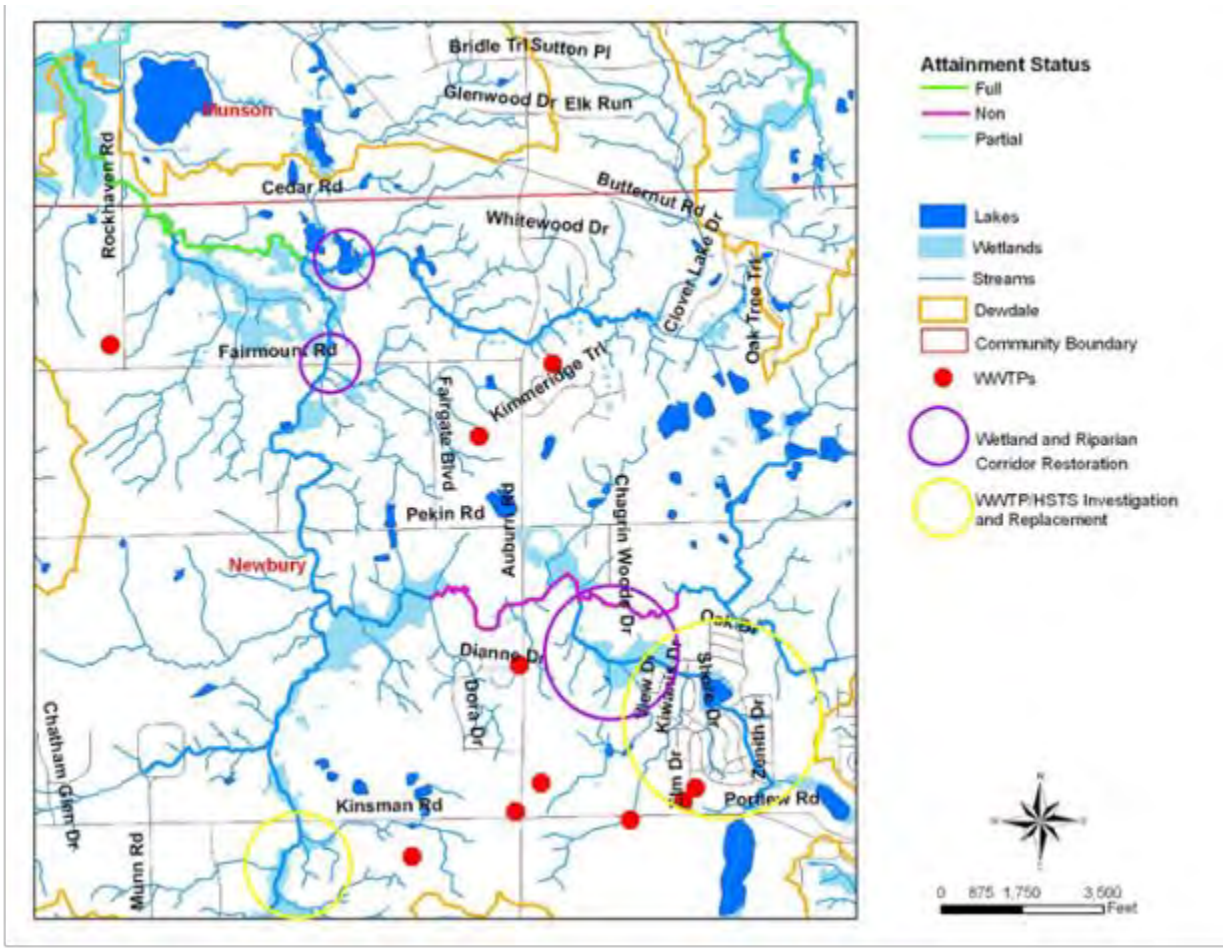


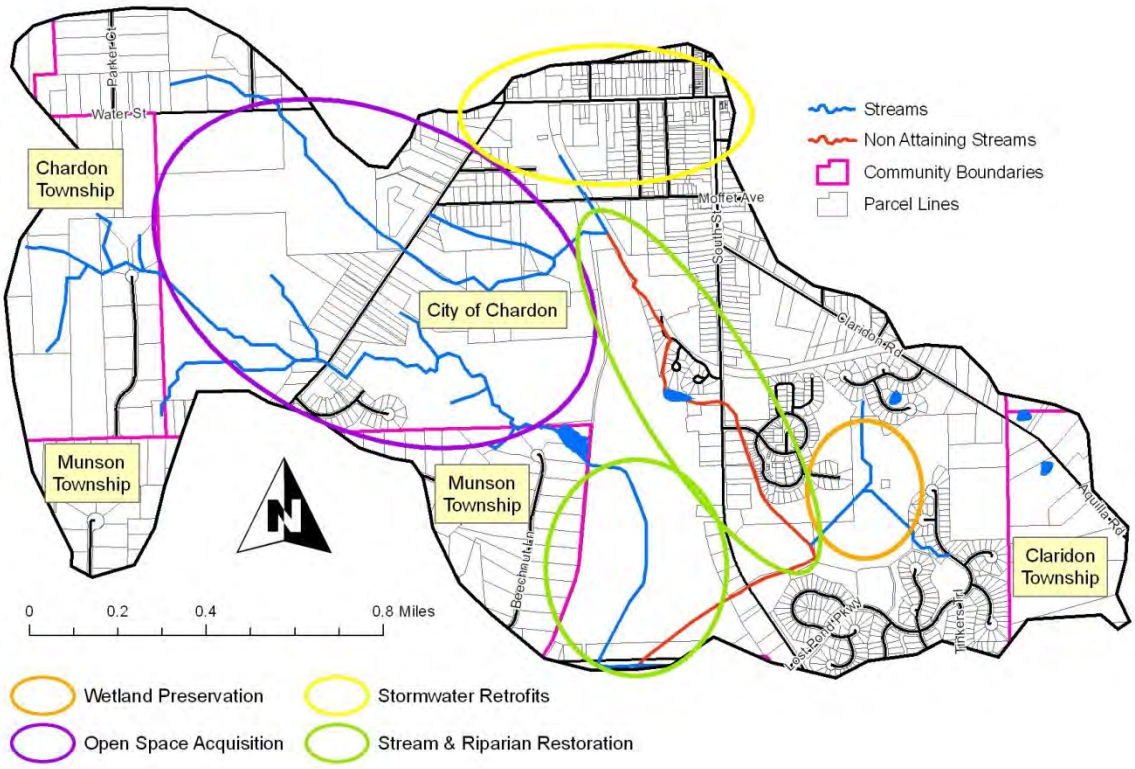
Figure 75: Recommendation Map for Dewdale Creek.

Wetland and riparian corridor restoration, while important, is not likely to be enough to bring the non-attaining portions of this stream into attainment of CWH life use. This stream is impacted by bacterial loads resulting from HSTS and point discharges from WWTPs.

- Wetland and riparian corridor restoration areas include:
  - Restore channelized wetlands on Township property upstream of Auburn Road to allow flow to spread throughout the entire wetland as opposed to stream isolation and disconnection from natural wetland hydrology.
  - Riparian corridor restoration downstream of Fairmount as noted above.
  - Further investigation of in-line flows in the Swetland ponds may also yield a potential restoration site.
- The area circled in yellow represents residential areas with very old HSTSs. These residences were initially conceived as summer cottages and have been converted to year-round use without updating the HSTS. Assistance to fund HSTS replacements in this area or allowing this area to become sewered will have to be investigated. Educational outreach to residents of this area, including the Kiwanis Lake Homeowner Association, is recommended.
- More investigation into bacterial and ammonia sources is necessary, requiring coordination with the Geauga County Health Department to see if HSTS and WWTPs need more effective treatment systems or if the smaller WWTPs could be consolidated into larger WWTPs.

- Preserve remaining wetlands, particularly at Burlington Oval and Woods of Burlington subdivisions;

- Open space acquisition and preservation, targeting parcels marked as Priority Conservation Areas in the *Chagrin River Balanced Growth Plan;*
- Riparian restoration: replace turfgrass along streambanks with native shrubs, trees, and grasses
- Stream restoration: restore sinuosity and floodplain access to non attaining stream segments;
- Integrate more natural areas into Chardon Lakes Golf Course grounds, plant native vegetation along streams, restore channelized stream segments, assist Chardon Lakes with developing a nutrient management program;
- Implement stormwater retrofits in the high-intensity commercially developed areas of City of Chardon to reduce stormwater flows into the stream;
- Integrate good housekeeping standards into City of Chardon's municipal service facilities to match Phase II minimum control measures;



CRWP Recommendations for Headwaters Upper Main Branch Subwatershed.

Headwater areas are expected to experience increased effects from changing land use. In recent years, several new residential developments have been completed and the trend is expected continue. This will result in increased threats to headwater wetland and stream resources including potential encroachment on riparian areas. While stormwater runoff is not currently reported to be a problem, continued increased impervious cover can be expected to result in a change in stream hydrology. Protection of remaining headwater wetlands and restoration of impacted reaches upstream of Bass Lake are also targeted activities.

11.5 Silver Creek: 04110003-03-01

Silver Creek is represented by 12 digit HUC 04110003-03-01 and includes Silver Creek and the South Branch of Silver Creek. This tributary drains approximately 13.4 square miles of parts of Auburn, Bainbridge, Newbury, and Russell Townships and South Russell Village. The Silver Creek subwatershed has been the subject of interest since the 1975 Pilot Project Study (Three Rivers 1979) to the Geauga Park District stream restoration in 2003 and 2004.

In 1975, the land use in the Silver Creek watershed was 88% undeveloped including woods (50%), wetlands (6%), grasslands, fields and crops, with approximately 12% of the watershed developed as suburban residential areas (Three Rivers, 1979). Today, 14.5 percent (1,349.5 acres) of the watershed is held in protected open space through the Geauga Park District, (West Woods) or conservation easements.

The 305(b) and 303(d) report identifies causes of problems in this segment as mercury, unionized ammonia, chlorine, organic enrichment, thermal modifications, flow alteration, noxious aquatic plants, and other habitat modifications. Sources are identified as major industrial point sources, package plants, highway/road/bridge/sewer line construction, drainage/filling of wetlands due to development, natural, upstream impoundments, and onsite wastewater systems (HSTS).

11.5.1 Silver Creek

This tributary has historically had very good water quality. Silver Creek stream habitat is excellent in areas without impoundments. In addition, thick glacial deposits supply significant ground water that maintains a stable summer base flow and physical characteristics capable of supporting CWH designation. Sedimentation problems due to the breach of the Silver Creek Dam and reservoir in 1994 caused channel destabilization for an estimated 3,000 feet downstream of the dam. Geauga Park District completed a 3,200 linear foot natural stream channel restoration along this reach in 2005. Protection of a significant portion of the lower reaches of Silver Creek due to the creation of The West Woods Parks adds stability to this system and its biological productivity in perpetuity. Sedimentation problems upstream of the dam have also been noted (Mackey 2000). Development is occurring in the upper portion of the watershed and can be expected to continue.

The 1995 Ohio EPA report states that of the 6.6 miles of Silver Creek assessed, 3.3 miles are in full attainment while 3.3 miles are in partial attainment. In 2003, the upper reaches near Music Street were determined to be in full attainment of CWH status. The 2003/204 fish sampling indicate that Silver Creek meets CWH standards at Music Street, however Ohio EPA has deferred attainment status and designation decisions pending future assessment of lower reaches near the restoration area. These results indicate that the Geauga Park District restoration project has resulted in a significantly improved fish community. All chemical samples indicated attainment of CWH life use. The macroinvertebrate community in Silver Creek upper sampling location at Music Street was exceptional with ten times more sensitive taxa than tolerant taxa.

The reintroduction of native brook trout (*Salvelinus fontinalis*), a declining species, into the Silver Creek watershed highlights the importance of maintaining and protecting Silver Creek as a CWH stream. The cumulative effect of thermal and chemical loadings from numerous small point source discharges to Silver Creek could have a negative impact on the future of native brook trout populations in this watershed. Ohio EPA noted chemical and thermal loadings to its tributaries in the future need to be carefully evaluated. The Silver Creek mainstem needs to be protected, as it potentially serves as a migration route between brook trout population areas. High quality habitat (QHEI scores of 76.0 and 81.0) is present in Silver Creek. In the Ohio EPA 2003/04 sampling , 3 of 4 biocriteria scores were marginally exceptional to Exceptional (IBI = 46 with an exceptional narrative macroinvertebrate evaluation at RM 5.1 and ICI = 54 at RM 0.4). There is still recovery in lower Silver Creek from the

impoundment depositional bedload moving downstream (IBI = 40 in 2004) toward the mouth. A very small impoundment closer to the mouth interferes with recolonization migration from the Chagrin River and nearby tributaries of sediment intolerant fish including redside dace, river chubs, and rosyface shiners. All have been historically recorded in the upper Chagrin basin and in Silver Creek. Encroachment into the riparian zone has been limited except along some of the small head water tributaries. Russell Township adopted riparian setbacks, following CRWP model setbacks, in 2008.

11.5.2 South Branch Silver Creek

This tributary to Silver Creek has good water quality although development in the upper portion of the subwatershed has caused some decrease in overall quality of the stream. The flow regime has also been altered as a result of construction of inline impoundments. The stream has been stocked with native brook trout.

Ohio EPA sampling from 1995 and 2003/2004 indicated the South Branch of Silver Creek was in full attainment of WWH status, although the site sampled in the South Branch only marginally met due to the influence of an upstream impoundment.

In 2013, CRWP visited Lake Louise in the headwaters of the South Branch of Silver Creek and noted significant HSTS discharge from upstream subdivisions. These areas should be investigated for possible sanitary sewer connections or upgrades of HSTS.

11.5.3 Affelder Tributary (RM 2.23)

Ohio EPA designated this stream as CWH due to native brook trout reintroduction.

11.5.4 Pebble Brook (RM 3.5)

Ohio EPA designated this stream as CWH due to native brook trout reintroduction.

11.5.5 Hrabak Tributary (RM 4.54)

Ohio EPA designated this stream as CWH due to native brook trout reintroduction.

11.5.6 Pettibone Tributary (RM 4.58)

Ohio EPA designated this stream as CWH due to native brook trout reintroduction.

11.5.7 Summary and Recommendations

Stormwater management retrofit projects and extension of sanitary sewers or HSTS upgrades, particularly in South Russell, may be sufficient to minimize impacts to the South Branch of Silver Creek. CRWP encourages the adoption of riparian setbacks in Newbury Township. Education of private property owners regarding protection of this unique resource and encouraging further local activity and land protection should be pursued.

11.6 Lower Aurora Branch: McFarland Creek-Aurora Branch: 04110003-03-03

The Lower Aurora Branch: Aurora Branch and McFarland Creek subwatershed is represented by 12 digit HUC 04110003-03-03 and includes the Aurora Branch from McFarland Creek to the Chagrin River, McFarland Creek, and unnamed tributaries. The 305(b) and 303(d) report identifies causes of impairment in this segment as mercury, unionized ammonia, chlorine, organic enrichment, thermal modifications, flow alteration, noxious aquatic plants, and other habitat modifications. Sources are identified as major industrial point sources, package plants, highway/road/bridge/sewer line construction, drainage/filling of wetlands due to development, natural, upstream impoundments, and onsite wastewater systems (HSTS).

This subwatershed and major tributaries problems may be attributed to a combination of onsite wastewater systems, point source discharges, stream bank modification/destabilization and effects of increased stormwater runoff due to changing land use. Rapid development is expected to continue. Of the subwatershed areas, this area is expected to experience the greatest pressures from changing land use. There is ample evidence of the effects of suburbanization on streams. Sedimentation associated with construction and channel erosion can be observed just upstream of the Solon-Chagrin Road crossing of the Chagrin River.

Despite the increased suburban development and waste water discharges the Aurora Branch and its tributaries generally have good to excellent habitat. Some impacts are noted due to somewhat embedded substrates in riffle habitats.

11.6.1 Lower Aurora Branch

Prior to 1987, the Aurora Branch was designated as CWH. Ohio EPA sampling in 1987 indicated a clear WWH community in this reach of the Aurora Branch. Macroinvertebrate sampling at this time indicated an exceptional to very good habitat. In 1991, habitat scores were exceptional and macroinvertebrate scores exceeded WWH and even equaled or exceeded the EWH criteria, but siltation and embedded substrates were noted just downstream of McFarland Creek. Impacts to the fish community were noted upstream of McFarland WWTP (RM 3.46). The 1995 Ohio EPA Water Quality study indicated full attainment of WWH along this segment. In 2003/2004 sampling, the IBI scores were lower than in previous sampling events. Suburban development and WWTP discharges appear to be major sources in this area. The Geauga County Water Department upgraded the McFarland WWTP to include a membrane filter system in 2006. In the 2004 Ohio EPA sampling, the Aurora Branch was in partial attainment of WWH use downstream of the McFarland WWTP, but in full attainment downstream to mouth. Overall, 42% of the sites in the Aurora Branch were impaired in the 2003-04 sampling as compared to 60% in the 1995-96 sampling, which shows some improvement. In addition, the lower 0.5 mile of the Aurora Branch was designated as SSH. Ohio EPA recommends the implementation of any "first flush" controls that would help decrease nutrient and sediment inputs and that decrease water temperatures, particularly bioretention and riparian protection.

11.6.2 McFarland Creek (RM 3.73)

This subwatershed has experienced significant sedimentation. Stream bank erosion is evident along much of the lower portions of the watershed. The stream has been destabilized due to a combination of factors including heavy sedimentation during the construction of Route 422, increased stormwater runoff due to increased impervious cover, and general construction activities. Portions of the stream have been impounded, particularly in the headwater areas. In general, problems are expected to continue to worsen due to the changing watershed hydrologic regime attributed with changing land use.

In 1995, Ohio EPA determined that McFarland Creek was in partial attainment of EWH aquatic life use. Data from Ohio EPA 2003/2004 sampling seasons indicated impacts of sedimentation due to a housing development (Canyon Lakes) and habitat disturbance from the bridge construction for Chagrin Road crossing over the North Branch of McFarland Creek,. McFarland Creek is in partial attainment of EWH use in 2004 sampling from Lake Lucerne outlet and North Branch confluence. Field observations indicate excessive siltation and embedded rock substrates as a significant cause on nonattainment. No violations of EWH chemical criteria were noted. Ohio EPA recommends the implementation of any "first flush" controls that would help decrease nutrient and sediment inputs and that decrease water temperatures, particularly bioretention and riparian protection.

11.6.3 North Branch McFarland Creek

From the 2004 sampling, Ohio EPA designated of this tributary as a CWH stream. Sampling results showed the stream to be in full attainment of CWH standards, but notes that the stream is threatened by habitat alteration from land development/suburbanization, specifically the bridge constructed where Chagrin Road crosses the North Branch of McFarland Creek.

11.6.4 Summary and Recommendations

The Aurora Branch is expected to experience the largest population growth over the next 25 years based on NOACA/NEFCO population forecasts. Subsequently, additional changes in land use can be expected. These changes will result in generation of additional wastewater and stormwater loadings to the Aurora Branch and associated effects on stream quality and wetland resources. Finally, there is likely to be additional encroachment into riparian areas, resulting in loss of riparian vegetation and stream bank modification/destabilization. The adoption of riparian setbacks in Solon and South Russell and enforcement of the riparian setback regulations in Bainbridge, Bentleyville, and Aurora should be facilitated and encouraged. Education of private property owners regarding protection of this unique resource and encouraging further local activity and land protection should be pursued. In addition any land preservation and restoration projects that can be identified and completed within this watershed will assist this stream to assimilate the impacts from past development activities. Working with entities such as local land trusts, local communities, Portage Park District and the Audubon Society of Greater Cleveland to help maintain existing lands and identify additional opportunities for protection is encouraged. Finally management of large lakes and potentially hazardous dams such as Briar Hill Lake, Tanglewood Lake, and Lake Lucerne must be considered. Ohio EPA recommends performing additional biological surveys of tributaries downstream from RM 11.0 to identify streams that serve as potential refugia for cold water fish, macroinvertebrates, and salamanders.

11.7 Headwaters Aurora Branch: Aurora Branch upstream of McFarland: 04110003-03-02

The Headwater Aurora Branch subwatershed is represented by 12 digit HUC 04110003-03-02 and includes the Aurora Branch upstream of McFarland Creek and Smith Creek, Linton Creek and numerous unnamed tributaries. The 305(b) and 303(d) report identifies causes in this segment as mercury, unionized ammonia, chlorine, organic enrichment, thermal modifications, flow alteration, noxious aquatic plants, and other habitat modifications. Sources are identified as major industrial point sources, package plants, highway/road/bridge/sewer line construction, drainage/filling of wetlands due to development, natural limitations, upstream impoundments, and onsite wastewater systems (HSTS).

This subwatershed and major tributaries problems may be attributed to a combination of onsite wastewater systems, point source discharges, stream bank modification/destabilization and effects of increased stormwater runoff due to changing land use. Rapid development is expected to continue. Of the subwatershed areas, this area is expected to experience the greatest pressures from changing land use. There is ample evidence of the negative effects of suburbanization on streams.

11.7.1 Aurora Branch Main Stem

Prior to 1987, the Aurora Branch was designated as CWH based on a visual assessment. Ohio EPA sampling in 1987 indicated a clear WWH community in lower reaches of the Aurora Branch. Ohio EPA's 1991water quality report noted partial attainment of the WWH status. After the 2003-2004 sampling, the stream segments between Smith Creek and McFarland Creek were designated as CWH once again. During the 1995 sampling by Ohio EPA a sewer line broke on Aurora Branch causing non attainment of this section. This section showed a marked improvement in IBI and ICI scores during the 2003-2004 sampling by Ohio EPA indicating recovery of the stream from this point source impact and improving fish communities downstream of Aurora Central WWTP. However, impacts were still noted in 2004 near Brewster Road downstream of a sand and gravel operation, where the stream is in partial

attainment at this point, but recovering to full attainment downstream. Upstream of the Aurora Central WWTP approximately 7.5 miles of stream are in either partial or non attainment. Causes of non-attainment are linked to organic enrichment and chronic toxicity due to algae blooms from Sunny Lake, discharge from WWTPs, removal of riparian habitat for golf courses.

At Chamberlain Road (RM 16.35), nutrient enrichment was observed during chemical sampling that may be attributed to WWTP discharges from Robin Mobile Home Park, Jellystone Park and Cantex cooling water. The higher nutrient levels may contribute to non-attainment of this stream as seen in the poor macroinvertebrate community.

The 1990 study of freshwater mussels (Unionidae) by Michael Hoggarth of ODNR showed that this segment of the Aurora Branch supported five species of mussels. However, only 12 specimens were collected in the Aurora Branch which does not represent a vibrant population. None of the freshwater mussel species found was rare. The study further noted that any threat that reduces habitat diversity, water quality, or substrate stability has the potential to significantly reduce the freshwater mussel species diversity.

The City of Aurora has protected numerous properties as public parks throughout the City, many of which contain the Aurora Branch and its tributaries. In 2013, the City of Aurora acquired the Aurora Golf Club with funding through Ohio EPA's WRRSP program. The decision of the WRRSP program to award Aurora the funds to purchase and restore this 186 acre property is currently under review by the ERAC. If the project is allowed to move forward it will result in the protection of an additional 186 acres of open space including 8,300 linear feet of the Aurora Branch of the Chagrin River, 15 acres of category 2 and 3 wetlands, and 5,800 linear feet of headwater stream. This project will restore an additional 900 linear feet of headwater stream, remove one dam, restore 3,500 linear feet of the Aurora Branch of the Chagrin River, and 33 acres of forested riparian corridor and floodplain. Restoration efforts will focus on restoring a natural stream corridor through bioengineering on streambanks, removal of tile, current structures, and steel sheet pile. Restoring the riparian area to native woodland will help shade the Aurora Branch, stabilize the banks, prevent erosion, control runoff, and significantly reduce the amounts of nutrients and other chemicals from entering the stream. Restoring the forested floodplain and riparian corridor will assist with exclusion of geese, eliminate fertilizer and herbicide runoff, and reduce sediment loads, all of which contribute to increased bacteria levels and algal blooms within the Aurora Branch of the Chagrin River.

11.7.2 Smith Creek (RM 8.98)

Near the mouth of this tributary is the Centerville Mills Camp, formerly a YMCA camp, and now owned and operated by Bainbridge Township. The Centerville Mills camp is the location of a historic mill dam that breached in the 1960's. The stream at this location is channelized along the existing dam that is showing some signs of instability. This stream also appeared to be impacted by recent bridge construction along Crackel Road. Smith Creek is a clear, cooler, spring-fed stream with lots of larger cobble, rubble and boulders present. There was a good riparian corridor upstream from South Spring Valley Rd. (RM 1.1) protecting the banks and shading the stream, and the stream temperature was 17.4ºC in 2004. Ohio EPA sampled this stream for the first time in 2004 and results indicated good habitat scores, exceptional macroinvertebrate community, but only a moderately good fish community, however the stream was determined to be in full attainment of the recommended CWH use. Ohio EPA biological sampling was completed at RM 1.1 while the chemical sampling was completed in the channelized section from the walking bridge crossing. Coldwater fish species found in this stream included Redside Dace and Brook Stickleback. This cold water stream contained an exceptional macroinvertebrate community with almost 60 percent of the sampled taxa were sensitive organisms (21 EPT taxa and 31 sensitive taxa), including baetid mayfly *Baetis tricaudatus* and cold water caddisfly *Ceratopsyche*

slossonae. Ohio EPA noted "set aside protection is important" Auburn, Aurora, and Bainbridge have all adopted riparian setbacks that should address this concern.

11.7.3 Tributary to Smith Creek (RM 0.6)

This stream was first sampled in 2004. This stream contains a very good cold water macroinvertebrate community and has a moderately intact riparian area. Ohio EPA designated this stream as CWH and determined it to be in full attainment of the CWH standards. Ohio EPA noted that development pressure in the area could adversely affect continued CWH performance, thus existing riparian setbacks and appropriate stormwater management are needed to protect this stream.

11.7.4 Linton Creek/Stoney Brook (RM 5.27)

This stream has been affected by minor municipal point source and by land development/suburbanization. In the 1995 and 2003/2004 Ohio EPA sampling, Linton Creek was determined to be in full attainment of the CWH aquatic life use. Native brook trout (*Salvilinus fontinalis*) were reintroduced in Linton Creek. Kenston Lake was an approximately 7 acre lake created by damming the headwater of Linton Creek. Historically, the Kenston Lake dam overtopped several times, causing downstream sedimentation. CRWP has worked with Bainbridge Township, Geauga County, Kenston Lake residents, and ODNR regarding removal of the Kenston Lake dam and restoration of a free-flowing stream through this segment and in 2008, helped Bainbridge Township secure funding through the Ohio EPA 319 grant program to remove the Kenston Lake dam and restore 1200 linear feet of stream in Linton Creek. The dam has been removed and the restoration project was completed in November 2011. Preliminary results from follow up sampling by Ohio EPA staff in 2013 indicated lower IBI scores as the headwater nature of the restored stream does not support a fish community, however improved macroinvertebrate scores show recovery in this area. As the riparian corridor in the restored lake continues to mature this restoration will have additional benefits to protect the downstream CWH status of Linton Creek.

11.7.5 Sunny Lake

This lake has been affected by a combination of urban runoff and upstream sources of contamination. Sunny Lake is highly eutrophic and experiences blooms of cyanobacteria. Toxins from these bacteria affect the stream about 5 miles downstream. Also, the lake has experienced stream bank erosion and has a high turbidity problem due to the presence of amurs, bottom-feeding fish that keep sediments suspended in the small recreational lake. Stream restoration activities upstream of this lake may assist in lowering the nutrients loadings to Sunny Lake. In addition the dam currently does not meet ODNR's dam safety regulations. CRWP will continue to work with the City of Aurora on options for upstream restoration and dam modifications and repairs to improve the water quality and safety of Sunny Lake. In 2007, the City of Aurora's Save Sunny Lake Committee completed a report with the assistance of Ohio EPA that noted that several recommendations including:

- Stabilize Sunny Lake shoreline
- Continue efforts to remove carp, grass carp, and bluegill in the lake.
- Direct watershed restoration efforts at the southern tributary to Sunny Lake.
- Monitor fish community in Aurora Branch in 2008, 2010, and 2012 and create a simplified lake monitoring program.
- Exclude Canada geese from Sunny Lake.
- Evaluate restroom facilities at Sunny Lake Park boathouse.
- Evaluate the existing dam and spillway to determine the integrity, functional ability and safety of the dam.
- Encourage Aurora City Schools to become an active partner in the restoration.

As a follow up, the boat house at Sunny Lake was being discharged directly to the Lake increasing pollutant loads. Bathrooms in the boat house were tied into a sanitary sewer system in 2012. In 2007-2008, the City drained Sunny Lake and removed all of the fish. After the fish were removed the water

level was restored and the shoreline is being stabilized with grasses by limiting mowing activity, which should deter goose populations. No follow up sampling has occurred to monitor the success of these initiatives.

In 2011, the City of Aurora received a 319 grant from Ohio EPA to restore approximately 3,190 linear feet of stream and floodplain and 3.1 acres of wetland, enhance 4 acres of existing wetland, preserve 8.6 acres of wetland, restore and enhance 17.5 acres of riparian and wetland buffer, and preserve 100 acres of property including restored resources. This property is at the headwaters of both the Aurora Branch of the Chagrin River watershed and the Cuyahoga River watershed. The stream restoration is all within the Chagrin watershed portion of the property while the wetland restoration, enhancement and preservation are split between the two watersheds. This project will further improve water quality to Sunny Lake by restoring these features and was completed in spring of 2013. In addition, CRWP continues to work with the City of Aurora on possible restoration of streams and wetlands on additional City owned parcels upstream and surrounding Sunny Lake.

11.7.6 Summary and Recommendations

CRWP has worked with the City of Aurora regarding several stream and wetland mitigation projects (3 of which are upstream of Sunny Lake). In addition, the City of Aurora and Bainbridge Township have adopted riparian setbacks. The City of Aurora has also adopted wetland setbacks. CRWP will continue to work to ensure the consistent application of these zoning controls and work with Mantua Township to encourage adoption of riparian setbacks. CRWP believes the completion of the above projects, including the pending Aurora Golf Club restoration, will ensure the full attainment of the Aurora Branch at this location.

The Centerville Mills dam has several areas of erosion due to the channelization of Smith Creek. Stream and floodplain restoration at this location would assist in enhancing the habitat in this location. Numerous other dams are present within this subwatershed. CRWP will continue to work with property owners of options for dam removal and dam safety concerns. This entire subwatershed is threatened by continued development pressure. CRWP will continue to work with the communities and residents within this subwatershed to maintain designated aquatic life uses by encouraging stormwater retrofits, stream naturalization, riparian reforestation and complete restoration to habitats and wetlands to meet standards where necessary.

12 Chagrin River Total Maximum Daily Loads (TMDL)

TMDLs represent the amount of total pollutant a stream can receive and still meet water quality standards. The TMDL process establishes allowable loadings based on wasteload allocations for existing point sources, nonpoint sources, and natural background. TMDLs are composed of the sum of individual wasteload allocations (WLAs) for point sources and load allocation for nonpoint sources and natural background, plus a margin of safety. WLAs were established for individual NPDES permits as well as MS4's under Phase II. The WLAs for individual facilities are summarized in Table 25.

Table 25: Parameter Concentrations

Total Phosphorus	1 mg/L
Nitrite-nitrate	5 mg/L
Total Suspended Solids	18 mg/L

The primary causes of impairment in the Chagrin River watershed are organic enrichment, nutrients, flow alteration, and habitat degradation. Major sources of impairment include land development/suburbanization, sewage treatment plants, wetland filling, removal of riparian vegetation, urban stormwater and nonpoint sources. In 2007, Ohio EPA prepared TMDLs for phosphorus, nitrates,

habitat, bacteria, and total suspended solids. The TMDL report details reasonable assurances to address both point and nonpoint sources of pollution. The following discussion details TMDL modeling results, numerical targets, and controls for the Chagrin River watershed.

12.1 Water Quality Summary by 10 digit HUC

12.1.1 Aurora Branch-Chagrin River HUC 04110003-03

This 10 digit HUC includes the Upper Main Branch, Silver Creek and the Aurora Branch of the Chagrin River. Land use changes and waste water discharges negatively impact the water quality in this watershed. In chemical sampling, the ammonia concentrations were low, but the nitrate and phosphorus concentrations showed some elevated levels. The maximum nitrate concentration found was 4.34 mg/l with a 95th percentile value of 2.33 mg/l. The maximum phosphorus concentration was 0.798 mg/l with a median concentration of 0.07 mg/l. Of the 134 dissolved oxygen samples taken, eight (5.9%) had concentrations less than 5 mg/l. Of the metals sampled, results indicated compliance with water quality. One sample in the Aurora Branch had a mercury sample above detection limits.

As stated in Section 11, several reaches of the Chagrin River upstream of Sperry Road do not meet water quality standards based on biological criteria. The river is in full attainment at RM 40.0 to the confluence with the Aurora Branch at RM 28.2. The Aurora Branch also shows signs of impairment. Possible impacts to the Aurora Branch's fish community are due to blue-green algae blooms from Sunny Lake. The stream recovers except for river mile 3.4 downstream of the McFarland Creek WWTP that shows fish community impairment. McFarland Creek is the only designated exceptional warm water habitat stream in the Chagrin River basin and is in partial attainment due to low fish community scores. Dewdale Creek at RM 2.6/Auburn Road is in nonattainment of its CWH life use and Marsh Hawk Run is in nonattainment of WWH biological community goals.

Bacteria analysis in this HUC is in partial attainment of the recreation use criteria. Elevated bacteria levels noted during high or runoff events are likely caused by nonpoint sources rather than failures at point source dischargers. Bacteria problem areas and possible sources identified in this HUC include:

- Dewdale Creek downstream of Kiwanis Lake likely due to failing on-site HSTS.
- Marsh Hawk Run receives HSTS inputs, discharge from the Opalacka WWTP, and nonpoint pollution from small farm livestock management.
- Chagrin River mainstem at Sperry Road likely due to failing on-site HSTS.
- Chagrin River mainstem in the Chagrin Falls area from combination of HSTS, WWTP, combined with potential wildlife contributions.
- Lower Aurora may be due to urban runoff from suburban areas like Solon and Bainbridge, and runoff from small-scale livestock management.

12.1.2 East Branch Chagrin River-Chagrin River HUC 04110003-04

The lower 10 digit HUC also showed impacts from land use changes and water discharges, although monitored pollutant concentrations were slightly lower than upper HUC. Similar to the upper HUC, ammonia concentrations were low while the nitrates and phosphorus showed some elevated levels. The maximum nitrate concentration found was 2.96 mg/l with a 95th percentile value of 1.43 mg/l. The maximum phosphorus concentration was 0.466 mg/l with a median concentration of 0.047 mg/l. Of the metals sampled, results indicated compliance with water quality. Of the 126 dissolved oxygen samples taken, only two (1.5%) had concentrations less than 5 mg/l.

The entire lower mainstem Chagrin River is in full attainment of its aquatic life use. Several tributaries, including Ward Creek, East Branch at RM 2.4, and Griswold Creek at RM 0.1, are in nonattainment of biological community goals.

The lower Chagrin HUC is also in partial attainment of the recreation use water quality criteria likely caused by nonpoint sources of pollution. Problem areas due to elevated bacteria noted in this HUC include:

- East Branch subwatershed likely sources are failing HSTS and a large number of small-scale equestrian facilities in this subwatershed.
- Stoney Brook due to failing package plants proposed to be served by central sewers in the near future.
- Gully Brook is highly developed in some portions while other portions are impacted by road runoff from the I-90 corridor and mixed residential land use.

Sampling indicates that the bacteria pollution may be more widespread than the current data indicates. Additional data, particularly data collected at high flows, would indicate a greater degree of nonattainment of recreational standards. Ohio EPA noted that a watershed-wide effort to reduce the loading of bacteria is needed to assure attainment of recreational standards.

12.2 Target Identification

TMDL targets are goals for load reduction and habitat improvement. Final determination of attainment status is determined by biocriteria, including IBI, ICI, MiWB and the success of TMDL implementation will be determined by attainment of the biocriteria. Ohio EPA identified TMDL targets for nitrate, phosphorus, habitat, bacteria, total suspended solids, and coldwater temperature for CWH streams as detailed below.

12.2.1 Nutrients

Ohio EPA does not have statewide numeric criteria for nutrients, but potential targets have been identified for TMDL use. Nitrate targets are consistently met within the watershed.

Table 26: Target Phosphorus Concentrations

Headwaters	<20 mi^2	0.08 mg/l
Wadable	> mi^2 <200 mi^2	0.10 mg/l
Small Rivers	>200 mi^2 <1000 mi^2	0.17 mg/l

Table 27: Target Nitrate-Nitrite Concentrations

Headwaters	<20 mi^2	1.0 mg/l
Wadable	> mi^2 <200 mi^2	1.0 mg/l
Small Rivers	>200 mi^2 <1000 mi^2	1.5 mg/l

The following table details the percent of samples/streams exceeding target nutrient values in the Chagrin River Watershed.

Table 28: Deviations from TMDL Nutrient Targets

		Percentage of samples greater than target values		
		Headwater	Wading	Small River
HUC 04110003-03 Aurora Branch-Chagrin River (headwaters to downstream Aurora Branch)	Nitrates	18.2%	12.5%	N/A
	Phosphorus	41.8%	17.5%	N/A

		Percentage of samples greater than target values		
		Headwater	Wading	Small River
HUC 04110003-04 East Branch Chagrin River-Chagrin River (downstream Aurora Branch to mouth)	Nitrates	11.5%	16.0%	0.0%
	Phosphorus	19.2%	6.0%	4.5%

Habitat quality influences a streams ability to process nutrients, thus it is anticipated that habitat improvements along with phosphorus and nitrate reductions will result in attainment of biocriteria.

12.2.2 Habitat and Total Suspended Solids

No statewide criteria have been developed for sediments of Total Suspended Solids (TSS). Ohio EPA uses data from similar watershed to determine targets for TSS.

Table 29: TSS Targets

Drainage Area	High Flow Target	Base Flow Target
Headwaters (< 20 square miles)	17 mg/L	5 mg/L
Wadeable (20 < 200 square miles)	53 mg/L	5 mg/L
Small Rivers (200 < 1000 square miles)	70 mg/L	5 mg/L

Targets for specific QHEI attributes are used as a surrogate to serve as management goals for efforts to restore, enhance, or protect aquatic life use in streams as noted in the table below. The QHEI target for WWH is 60, with a score of 75 indicating excellent stream habitat. For QHEI target of 60, only 4 sites failed to meet the target as detailed in Table 30.

Table 30: Streams not meeting QHEI target

	River Mile	Year	QHEI
Quarry Creek	0.10	2004	55.0
Chagrin River	49.10	2003	23.0
Aurora Branch	1.00	2003	54.0
Chagrin River	42.60	2003	58.0

The sediment and habitat TMDLs are based on a subset of the QHEI metrics. The habitat TMDL target for the Chagrin is 3 and is a sum of three component scores:

1. QHEI score to Target Ratio
2. Modified Attribute Score
3. High Influence Attribute score

A QHEI score less than the target, the presence of one high-influence attribute, or more than 4 moderate influence attributes will prevent a stream from achieving the target. The sediment TMDL is a subset of factors of the WHEI directly related to sediment type, quality, build up and source origin. The sediment TMDL target is a minimum of 33. The individual components have targets that are analogous to allocations.

1. Substrate – Minimum of 14
2. Channel Morphology – Minimum of 14
3. Riparian Zone/Bank Erosion – Minimum score of 5.

Table 31: Details of Habitat and Sediment TMDLs

QHEI Categories		Modified Attributes			
Category	Target	High Influence		Moderate Influence	
Substrate	14	➢ Channelized or No Recovery ➢ Silt/Muck Substrates ➢ Low Sinuosity ➢ Sparse/No Cover ➢ Max Pool Depth < 40 cm		➢ Recovering Channel ➢ San Substrate (boat Sites) ➢ Hardpan Substrate Origin ➢ Fair/Poor Development ➢ Only 1-2 Cover Types ➢ No fast Current ➢ High/Moderate embeddness ➢ Ext/Mod Riffle Embeddedness ➢ No Riffle	
Channel	14				
Instream Cover	12				
Riparian	5				
Pool/Current	Sum of these >15				
Riffle/Run					
Gradient					
QHEI score	60				
QHEI Target Ratios	+1	One or less high influence attributes present	+1	Four or less moderate influence attributes present	+1

12.2.3 Bacteria

All streams in the Chagrin are listed as Primary Contact Recreation. Targets have been identified for Fecal Coliform and E.coli as noted below.

Table 32: Bacteria Standards

Parameter	Bathing Waters		Primary Contact Recreation		Secondary Contact
	Geometric Mean	Instantaneous	Geometric Mean	Instantaneous	Instantaneous
Fecal Coliform	200/100 ml	400/100 ml	1,000/100 ml	2,000/100 ml	5,000/100 ml
E. Coli	126/100 ml	235/100 ml	126/100 ml	298/100 ml	576/100 ml

12.2.4 Temperature

Targets were set for temperature for CWH streams in the Chagrin watershed. The targets were based on temperature data gathered by ODNR. In addition, Ohio water quality standards state "At no time shall the water temperature exceed the temperature which would occur if there were no temperature change attributable to human activities." CWH streams in the Chagrin must meet both the numeric and stated targets.

Table 33: Coldwater Temperature Targets (in Degrees Celsius)

	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
Monthly Average	4.0	4.4	5.5	8.8	11.7	14.3	15.3	15.4	14.3	10.9	9.3	5.1
Monthly Max	9.4	8.2	13.4	18.1	18.2	19.8	22.8	20.9	19.4	14.9	12.9	10.2

12.3 Implementation Actions

Ohio EPA identified 12 implementation actions in the Chagrin TMDL. Ohio EPA identified a managing party, time schedule, and reasonable assurances to complete the actions. The table below is excerpted from table 7-2 of the Chagrin TMDL report.

Table 34: Implementation Actions from Chagrin TMDL

#	Action	Managing Party	Schedule	Reasonable Assurances Description/Specifics
1	Phase II Stormwater programs	Ohio EPA, Local Soil Water Conservation Districts, Local Communities	Compliance beginning in March of 2003	U.S. EPA Phase II stormwater regulations
2	Wetlands Protection	Ohio EPA US Army Corps of Engineers	Existing rules	Sections 401 and 404 of the Clean Water Act. State of Ohio wetland regulations (OAC 3745)
3	Riparian protection	Local Governments, land protection agencies	Some existing, some proposed	No direct reasonable assurances. Ancillary assurances may be tied to Phase II stormwater regulations and comprehensive planning for local communities.
4	Low Impact Development Practices	Local Governments	Proposed	Local Regulations
5	Headwater stream protection	Ohio EPA, US Army Corps of Engineers, Local Governments	Ongoing	Sections 401 and 404 of the Clean Water Act.
6	208 updates	NOACA, NEFCO	Completed	Section 208 of the Clean Water Act
7	Evaluation of all dams in Chagrin River TMDL area for removal.	Ohio EPA, Individual dam owners, local park departments	Ongoing	Ohio Water Quality Standards
8	Household sewage disposal systems	Local Health Departments, Ohio Department of Health	Ongoing	State and local home sewage treatment system regulations.
9	House Bill 110 program	Local Health Departments, Ohio EPA	Ongoing	House Bill 110 allows health departments and Ohio EPA to enter into contract for the purpose of licensing and inspecting semipublic sewage disposal systems. Existing regulations are utilized (ORC 6111) NPDES permit limits Ohio EPA Ongoing Section 402 of the Clean Water Act, State of Ohio (ORC Chapter 6111)
10	NPDES Permit Limits	Ohio EPA	Ongoing	Section 402 of the Clean Water Act, State of Ohio (ORC Chapter 6111)
11	Watershed Action Plan	Ohio DNR/ Local Watershed	Ongoing	319 Funding obligations

#	Action	Managing Party	Schedule	Reasonable Assurances Description/Specifics
		Coordinator		
12	Educational Programs	Ohio EPA, Chagrin River Watershed Partners, Local Soil Water Conservation Districts	Ongoing	Continuation and expansion of existing educational programs.

The Chagrin River watershed TMDL makes a number of recommendations including:

- No new permits to impact Category 2 and 3 wetlands be issued in the Chagrin River TMDL area. All permits issued for impacts to Category 1 wetlands should ensure that mitigation is conducted on-site if possible and at a minimum within the watershed area. If mitigation cannot be conducted on-site or within the watershed area, then a permit should not be issued for the proposed project.
- Class III primary headwater habitats (PHWH) streams should be identified within 12 digit HUC for the entire Chagrin River basin using the Ohio EPA assessment techniques.
- Set maximum permit limits at 14 mg/l for TSS in all renewal permits that have current maximum limits of 18 mg/l.
- Return Sunny Lake to a historically natural state allowing for restoration of ecological balance. Reduction of upstream nutrients, restoration of the lake bathymetry should help to eliminate blue green algae.
- Work with small farming operations, ODNR, Ohio Department of Agriculture, and local SWCDs to develop conservation plans for these properties. Programs such as the Conservation Reserve Enhancement Program (CREP) should be utilized to protect stream riparian zones.

13 Chagrin River Watershed Problem Statements

Based on water quality data presented above, the Chagrin River has some areas that continue to be a high quality resource. However, several portions of each of the above subwatersheds are showing impacts largely due to development. Thus, CRWP and our stakeholders focus our watershed management efforts by:

- Protecting existing open space, streams and wetlands,
- Restoring those resources that have already been impacted,
- Influencing local development standards and practices to allow development to continue while maintaining the high quality of the Chagrin River.

The problem statements detailed below highlight areas that will direct our activities to maximize the improvements and protection efforts in the watershed. The following problem statements highlight the concerns noted through the available water quality data and water quality programs throughout the watershed.

1) Stream, floodplains, and wetlands continue to be impacted directly and indirectly by:
    a) Riparian corridor vegetation removal
    b) Channelization, culverting, or encroachment on streams.
    c) Filling of floodplains,
    d) Draining and filling of wetlands,
    e) Stormwater flows,

f) Channel instability, including stream bank erosion.

2) Bacteria levels are elevated above recreational use standards in numerous streams.
3) Flooding threatens residents and property through both localized and large scale events.
4) Sedimentation impacts biology in streams throughout the watershed and exacerbates dredging requirements at the Chagrin River mouth.
5) Impoundments, if constructed in line, interrupt the natural stream flow and many existing impoundments are often ignored and not properly maintained.

It is important to note that although these problems exist in the Chagrin River watershed, many of the streams in the watershed are attaining their designated aquatic life uses. Therefore, much of the focus of the goals below are intended to ensure the stream remains as a high quality resource, while working to restore those segments that are impacted.

14 Watershed Restoration and Protection Goals

Section 11 details both intact and impaired areas in each 12 digit HUC watershed of the Chagrin River drainage, Section 12 details goals and load reductions from the Chagrin TMDL, and Section 13 includes problem statements, and Section 14 discusses the restoration and protection goals watershed stakeholders will pursue to address these problems and specific implementation steps to meet these goals.

Seven (7) goals are identified to investigate and address the problems in the watershed and to protect the high quality areas to maintain their flood control, erosion control, water quality protection, and habitat functions. The following tables expand on these goals through tasks, responsible parties, evaluation mechanisms, funding, and status.

Goal 1 - Watershed Inventory, Planning, and Research: Continue to inventory the water resources in the Chagrin River watershed; detail the status of these resources; expand and improve inventories of problems and potential restoration projects; and develop or obtain timely information on emerging watershed problems and trends, stormwater management, and planning tools available for watershed management.

Goal 2 – Adoption of Best Local Land Use Practices: Conduct research and assist local governments with the adoption and implementation of best local land use practices to allow flexibility in site layout to reduce stormwater runoff and nonpoint source pollution, and to maintain the flood control, erosion control, and water quality protection features of sites including riparian areas and wetlands. Local practices and codes may include comprehensive planning, riparian and wetland setbacks, conservation development, stormwater management, erosion and sediment control, floodplain management, and meadow management.

Goal 3 – Protection of Open Spaces, Streams, Floodplains, and Wetlands: Promote and facilitate the protection of open spaces with emphasis on streams, wetlands, and riparian areas. As of December 2009, approximately 14% of the Chagrin watershed is protected.

Goal 4 – Restoration of Streams, Wetlands, and Floodplains: Promote and facilitate the restoration of streams, wetlands, and floodplains.

Goal 5 - Bacteria Level Reduction: Reduce stream bacterial levels to meet State water quality standards for recreational use.

Goal 6 –Ground water Quality and Quantity Protection: Protect ground water quantity and quality of the aquifer underlying Chagrin River communities by monitoring water withdrawals, increasing public awareness of the importance of ground water quality, investigating ground water recharge rates verses pumping rates, protecting local well field, and delineating and protecting significant recharge areas.

Goal 7 – Dams and Impoundment Management: Minimize the creation of additional online impoundments and ensure existing dams are safe and have the appropriate operation, maintenance, and inspection plans and emergency action plans.

14.1 Plan Goals, Tasks, and Implementation Strategies

Table 35 below details specific projects that CRWP and other watershed stakeholders will complete to fulfill the above goals. This table is organized by each of the 12 digit HUC watershed and includes action items, project type, causes and sources of impairment, costs, and status. Each of these projects and specific tasks associated with each project will be detailed through CRWP annual work plans.

Tables from 2006 version of the *Chagrin River Watershed Action Plan* are included in **Error! Reference source not found.** for historic record.

Table 35: Projects and action items to meet defined goals

Stream/Project Name	12 Digit HUC	ALU	Attainment Status	Causes	Causes	Project Type	Sources	Action Item	Unit	Target	Cost	Comments	Status
Assistance to schools, communities and residents to apply for stormwater credits in local stormwater utilities	04110003-03-04: Upper Main Branch	WWH	Partial	Flow Alteration		Prevention	Land Development/ Suburbanization	Restore Natural Flow	LF	600	$600,000	Install Stormwater BMPs to restore nature stream flow and infiltration capacities and allow property owners to obtain credits from local stormwater utilities	On hold pending status of NEORSD court ruling for stormwater program.
Beaver Creek	04110003-03-04: Upper Main Branch	WWH	Full	Direct Habitat Alterations		Prevention	Land Development/ Suburbanization	Conduct Fish (IBI) Sampling	Sites	2	$10,000	OEPA noted need to sample DS of Heather Hill - Future sampling DS of Heather Hill to determine if lower levels of phosphorus actually make a difference	Ohio EPA sampling scheduled for 2019
Construct innovative stormwater management BMPs to promote infiltration and restore natural flow	04110003-03-04: Upper Main Branch	WWH	Partial	Direct Habitat Alterations	Flow Alteration	Prevention	Land Development/ Suburbanization	Restore Natural Flow	LF	100	$100,000	Design and construct innovative stormwater BMPs to restore natural flow and infiltration to area streams	Locations under investigation
Munson Township Hall Retrofit Project	04110003-03-04: Upper Main Branch	WWH	Partial	Direct Habitat Alterations	Flow Alteration	Prevention	Land Development/ Suburbanization	Restore Natural Flow	LF	100	$100,000	Install innovative stormwater BMPs at Munson Township's Township Hall to restore natural flow and infiltration to watershed in partial attainment	In talks with Munson Township
Riparian and Wetland Protection	04110003-03-04: Upper Main Branch	WWH	Partial	Direct Habitat Alterations	Flow Alteration	Prevention	Land Development/ Suburbanization	Acquire Riparian and Wetland Conservation Easements	Acres	3000	$75,000,000	Acquire additional easements on riparian corridors and wetlands.	Continue to work with local park districts, land trusts, Holden Arboretum, communities, SWCDs.
Riparian and Wetland Protection	04110003-03-04: Upper Main Branch	WWH	Partial	Direct Habitat Alterations	Flow Alteration	Prevention	Land Development/ Suburbanization	Adoption of Local Conservation Statutes	Jurisdictions	16	$48,000	Riparian and wetland setbacks, erosion and sediment control, stormwater management, illicit discharge, floodplain management, conservation development and other best local land use practices	On-going CRWP goal to have 100% adoption of codes as appropriate across watershed.
Chagrin River (RM 42.6 to 45.3)	04110003-03-04: Upper Main Branch	WWH	Partial	Direct Habitat Alterations	Flow Alteration	Protection	Land Development/ Suburbanization	Acquire Riparian Conservation Easements	Acres	100	$25,000,000	Link Bass Lake, Munson Scenic River Retreat, & Rookery	Designated as a PCA in *Plan.*

Chagrin River US Bass Lake	04110003-03-04: Upper Main Branch	WWH	Non	Direct Habitat Alterations		Protection	Land Development/ Suburbanization	Acquire Wetland Conservation Easements	Acres	10	$250,000	Protect wetlands upstream of SR 44	Designated as PCA in *Plan.*
Dewdale Creek (RM 4.6) (Trib. at RM 42.55)	04110003-03-04: Upper Main Branch	CWH	Non	Nutrients	Natural Limits (Wetlands)	Protection	Drainage/Filling of Wetlands Channelization - Dev.	Acquire Wetland Conservation Easements	Acres	35	$875,000	Extensive wetlands with poor stream habitat	Designated as PCA in Plan. Considering as mitigation for development project or part of mitigation bank
Oberland Park - Newbury Twp	04110003-03-04: Upper Main Branch					Protection	Drainage/Filling of Wetlands Channelization - Dev.	Acquire Wetland Conservation Easements	Acres	22	$127,000	Preserve 21.9 acres of wetlands, enhance 9.5 acres, preserve 2,620 LF of stream and 21.6 acres of upland buffer	Proposed Mitigation Site for Mitigation Bank
Beaver Creek Stream and Wetland Restoration Geauga Park District	04110003-03-04: Upper Main Branch	CWH	Full	Direct Habitat Alterations		Restoration	Land Development/ Suburbanization	Reconstruct & Restore Wetlands	Acres	10	$300,000	Restore approximately 10 acres of riparian wetlands and 2,100 linear feet of Beaver Creek. Includes design/engineering, restoration, & monitoring.	
Beaver Creek Stream and Wetland Restoration Geauga Park District	04110003-03-04: Upper Main Branch	CWH	Full	Direct Habitat Alterations		Restoration	Land Development/ Suburbanization	Restore Stream Channel	LF	2100	$997,500	Restore approximately 10 acres of riparian wetlands and 2,100 linear feet of Beaver Creek. Includes design/engineering, restoration, & monitoring.	
Chagrin Falls Riparian Restoration at Service Facility	04110003-03-04: Upper Main Branch	WWH	Full	Direct Habitat Alterations		Restoration	Land Development/ Suburbanization	Plant Trees or Shrubs in Riparian Areas	LF	300	$225,000	Plant riparian area with native woody vegetation and remove existing salt dome from riparian area. Includes building new salt dome outside of riparian corridor.	Seeking funding sources
Chagrin River (RM 42.6 to 45.3)	04110003-03-04: Upper Main Branch	WWH	Partial	Direct Habitat Alterations	Flow Alteration	Restoration	Land Development/ Suburbanization	Restore Stream Channel	LF	5000	$1,000,000	Restore channelized segments	No Plans
Chagrin River at IVEX	04110003-03-04: Upper Main Branch	WWH	Full	Direct Habitat Alterations	Flow Alteration	Restoration	Upstream Impoundment	Restore Stream Channel	LF	2200	$640,000	Habitat fragmentation, free flowing reach isolated by impoundments	319 Grant acquired, plans developed, permits submitted, dam modification and stream restoration completed in 2012

Chagrin River US Bass Lake	04110003-03-04: Upper Main Branch	WWH	Non	Direct Habitat Alterations		Restoration	Land Development/ Suburbanization	Restore Stream Channel	LF	2000	$400,000	Restore channelized segment and consider innovative stormwater management	Design completed 2015 using Cleveland Foundation funding for stream restoration, in talks with City of Chardon and golf course owners
Chagrin River Watershed Riparian Restoration	04110003-03-04: Upper Main Branch	WWH	Partial	Direct Habitat Alterations	Flow Alteration	Restoration	Land Development/ Suburbanization	Restore Streambank Using Bio-Engineering	LF	5000	$250,000	Assist property owners with small stream bank stabilization projects, riparian corridor planting and elimination of stored materials in floodplains.	
Dewdale Creek (RM 4.6) (Trib. at RM 42.55)	04110003-03-04: Upper Main Branch	CWH	Non	Nutrients	Natural Limits (Wetlands)	Restoration	Onsite Wastewater Systems (Septic Tanks	Repair or Replace Traditional HSTS	HSTS	150	$2,250,000	Repair or replace 150 HSTS near Kiwanis Lake and upstream	No Plans
Marsh Hawk Run	04110003-03-04: Upper Main Branch	WWH	Non	Nutrients	Organic Enrichment/DO	Restoration	Onsite Wastewater Systems (Septic Tanks	Reduce Untreated Home Sewage	Gallons Per Day	100	$1,500,000	Replace or Repair HSTS and consider upgrades to WWTP	No Plans
Smith Creek	04110003-03-04: Upper Main Branch	CWH	Full	Siltation		Restoration	Land Development/ Suburbanization	Restore Streambank Using Bio-Engineering	LF	1000	$100,000	Bridge Construction and dam along river for Centerville Mills Pond	Seeking funding sources
Newbury Township Veteran's Memorial Park	04110003-03-04: Upper Main Branch	CWH	Non	Direct Habitat Alterations	Flow Alteration	Restoration	Land Development/ Suburbanization	Restore Natural Flow			$50,000	Bioretention and permeable pavement installation to treat stormwater runoff	Applied for SWIF and Naturworks in 2014, did not get funded- seeking additional funding
Woodiebrook Stream Restoration Geauga Park District	04110003-03-04: Upper Main Branch			Direct Habitat Alterations		Restoration	Land Development/ Suburbanization	Restore Stream Channel	LF	1400	$665,000	Restore 1,400 linear feet of CWH stream and associated State Threatened Species (Native Ohio Brook Trout) habitat. Scope includes design/engineering, restoration, and post restoration monitoring.	
Construct innovative stormwater management BMPs to promote infiltration and restore natural flow	04110003-03-01: Silver Creek	CWH	Partial	Direct Habitat Alterations	Flow Alteration	Prevention	Land Development/ Suburbanization	Restore Natural Flow	LF	100	$100,000	Design and construct innovative stormwater BMPs to restore natural flow and infiltration to area streams	Locations under investigation

Riparian and Wetland Protection	04110003-03-01: Silver Creek	CWH	Partial			Prevention	Land Development/ Suburbanization	Acquire Riparian and Wetland Conservation Easements	Acres	500	$12,500,000	Acquire additional easements on riparian corridors and wetlands.	CRWP will continue to work with local park districts, land trusts, Holden Arboretum, communities and SWCDs.
Riparian and Wetland Protection	04110003-03-01: Silver Creek	CWH	Partial			Prevention	Land Development/ Suburbanization	Adoption of Local Conservation Statutes	Jurisdictions	6	$18,000	Riparian and and wetland setbacks, erosion and sediment control, stormwater management, illicit discharge, floodplain management, conservation development and other best local land use practices	On-going CRWP goal to have 100% adoption of codes as appropriate across watershed.
Chagrin River Watershed Riparian Restoration	04110003-03-01: Silver Creek	CWH	Partial	Direct Habitat Alterations		Restoration	Land Development/ Suburbanization	Restore Streambank Using Bio-Engineering	LF	5000	$250,000	Assist property owners with small stream bank stabilization projects, riparian corridor planting and elimination of stored materials in floodplains.	
South Branch Silver Creek	04110003-03-01: Silver Creek	WWH	Full	Direct Habitat Alterations	Direct Habitat Alterations	Restoration	Upstream Impoundment	Remove Dams	Dams	5	$10,000,000	Low IBI due to upstream impoundments. Investigate dams for removal or add habitat structures to compensate for dams	No Plans
Construct innovative stormwater management BMPs to promote infiltration and restore natural flow	04110003-03-03: Lower Aurora Branch	WWH	Partial	Direct Habitat Alterations	Flow Alteration	Prevention	Land Development/ Suburbanization	Restore Natural Flow	LF	100	$100,000	Design and construct innovative stormwater BMPs to restore natural flow and infiltration to area streams	Locations under investigation
Riparian and Wetland Protection	04110003-03-03: Lower Aurora Branch	WWH	Partial			Prevention	Land Development/ Suburbanization	Acquire Riparian and Wetland Conservation Easements	Acres	2000	$50,000,000	Acquire additional easements on riparian corridors and wetlands.	CRWP will continue to work with local park districts, land trusts, Holden Arboretum, communities, SWCDs.
Riparian and Wetland Protection	04110003-03-03: Lower Aurora Branch	WWH	Partial			Prevention	Land Development/ Suburbanization	Adoption of Local Conservation Statutes	Jurisdictions	6	$18,000	Riparian and and wetland setbacks, erosion and sediment control, stormwater management, illicit discharge, floodplain management, conservation development and other best local land use practices	On-going CRWP goal to have 100% adoption of codes as appropriate across watershed.

South Russell Village Hall Retrofits	04110003-03-03: Lower Aurora Branch	WWH	Not Assessed	Direct Habitat Alterations	Flow Alteration	Prevention	Land Development/ Suburbanization	Restore Natural Flow	LF	100	$100,000	Install innovative stormwater retrofits to the South Russell Village Hall to restore natural stream flow and infiltrative capacity	In discussion with South Russell Village
McFarland Creek Bainbridge Twp	04110003-03-03: Lower Aurora Branch	EWH	Non			Protection		Acquire Riparian Conservation Easements	LF	4470	$120,000	Preserve high quality stream west of McFarland Creek WWTP	Proposed Mitigation Site for Mitigation Bank
Aurora Branch - Brewster Road	04110003-03-03: Lower Aurora Branch	WWH	Partial	Nutrients	Siltation	Restoration	Dredge Mining	Remove Dams	Dams	1	$400,000	Stream flows have cut around low head dam on Aurora Branch of Chagrin at DiMarco property. Remove lowhead dam, repair erosion along stream banks, and vertically stabilize river.	Working with landowners on SWIF application
Geauga County Library Retrofit Project	04110003-03-03: Lower Aurora Branch	WWH	Not Assessed	Direct Habitat Alterations	Flow Alteration	Prevention	Land Development/ Suburbanization	Restore Natural Flow	LF	100	$100,000	Install innovative stormwater retrofits to the Geauga County Library Parking Lot to restore natural stream flow and infiltrative capacity	In talks with Bainbridge Township
Chagrin River Watershed Riparian Restoration	04110003-03-03: Lower Aurora Branch	WWH	Partial	Direct Habitat Alterations		Restoration	Land Development/ Suburbanization	Restore Streambank Using Bio-Engineering	LF	5000	$250,000	Assist property owners with small stream bank stabilization projects, riparian corridor planting and elimination of stored materials in floodplains.	
McFarland Creek at RM 0.2-2.3	04110003-03-03: Lower Aurora Branch	EWH	Partial	Direct Habitat Alterations	Siltation	Restoration	Land Development/ Suburbanization	Restore Natural Flood Plain Function	Acres	1	$2,000,000	Research possible sources of stormwater and recommend widening of crossing at 422	No Plans
Construct innovative stormwater management BMPs to promote infiltration and restore natural flow	04110003-03-02: Upper Aurora Branch	WWH	Partial	Direct Habitat Alterations	Flow Alteration	Prevention	Land Development/ Suburbanization	Restore Natural Flow	LF	100	$100,000	Design and construct innovative stormwater BMPs to restore natural flow and infiltration to area streams	Locations under investigation
Riparian and Wetland Protection	04110003-03-02: Upper Aurora Branch	WWH	Partial			Prevention	Land Development/ Suburbanization	Acquire Riparian and Wetland Conservation Easements	Acres	2000	$50,000,000	Acquire additional easements on riparian corridors and wetlands.	CRWP will continue to work with local park districts, land trusts, Holden Arboretum, communities, SWCDs.

Riparian and Wetland Protection	04110003-03-02: Upper Aurora Branch	WWH	Partial			Prevention	Land Development/ Suburbanization	Adoption of Local Conservation Statutes	Jurisdictions	5	$15,000	Riparian and and wetland setbacks, erosion and sediment control, stormwater management, illicit discharge, floodplain management, conservation development and other best local land use practices	On-going CRWP goal to have 100% adoption of codes as appropriate across watershed.
Hartman Property - Aurora	04110003-03-02: Upper Aurora Branch	None	Not Assessed	Direct Habitat Alterations		Protection	Land Development/ Suburbanization	Acquire Riparian Conservation Easements	LF/Ac	5200/3	$140,000	There are opportunities to also create vernal pools and restore some around 300 LF of stream as well	Proposed Mitigation Site for Mitigation Bank
Aurora - Stormwater Retrofits at Sunny Lake	04110003-03-02: Upper Aurora Branch	WWH	Partial	Direct Habitat Alterations	Flow Alteration	Prevention	Land Development/ Suburbanization	Restore Natural Flow				Retrofit parking lots at Sunny Lake with permeable pavement	Possible SWIF proposal
Aurora- Wetland Restoration US of Sunny Lake	04110003-03-02: Upper Aurora Branch	WWH	Not Assessed	Direct Habitat Alterations		Restoration	Land Development/ Suburbanization	Reconstruct & Restore Wetlands	Acres	1	$50,000	Re-grade portion of the channelized stream segment and re-establish the berm to restore approximately 1 acre of wetland	Possible SWIF proposal
Chagrin River Watershed Riparian Restoration	04110003-03-02: Upper Aurora Branch	WWH	Partial	Direct Habitat Alterations		Restoration	Land Development/ Suburbanization	Restore Streambank Using Bio-Engineering	LF	5000	$250,000	Assist property owners with small stream bank stabilization projects, riparian corridor planting and elimination of stored materials in floodplains.	
Chesnes Property - Aurora	04110003-03-02: Upper Aurora Branch	None	Not Assessed	Flow Alteration		Restoration	Flow Regulation/Modification	Restore Natural Flow	LF	2000	$155,000	Remove pond and allow stream to flow through the property. Also may be potential for wetland preservation.	Proposed Mitigation Site for Mitigation Bank
Harmon Property - Aurora	04110003-03-02: Upper Aurora Branch	None	Not Assessed	Direct Habitat Alterations		Restoration	Land Development/ Suburbanization	Reconstruct & Restore Wetlands	Acres	3.1	$145,000	There are opportunities to preserve, enhance, and restore wetlands on this property.	Restored 3.1 acres of wetland in 2013
Harmon Property - Aurora	04110003-03-02: Upper Aurora Branch	None	Not Assessed	Direct Habitat Alterations		Restoration	Land Development/ Suburbanization	Restore Stream Channel	LF	3190	$330,000	Restore stream channel through property	Restored 3,190 linear feet of stream channel in 2013
Headwaters of the Aurora Branch (at river mile 14.4 & 16.3)	04110003-03-02: Upper Aurora Branch	WWH	Non	Nutrients	Organic Enrichment/DO	Restoration	Onsite Wastewater Systems (Septic Tanks	Repair or Replace Traditional HSTS	HSTS	150	$2,250,000	Repair or replace HSTS upstream of Sunny Lake	No Plans

Centerville Mills Stormwater Retrofits	04110003-03-02: Upper Aurora Branch	CWH	Full	Direct Habitat Alterations	Flow Alteration	Prevention	Land Development/ Suburbanization	Restore Natural Flow	Acres		$100,000	Treat 14,600 square feet of parking lot with 5,165 square feet of permeable pavements to attenuate stormater flow into Smith Creek	Funded through 319 program in 2014
Restoration of Aurora Branch of Chagrin River at Aurora Country Club	04110003-03-02: Upper Aurora Branch	WWH	Non	Direct Habitat Alterations		Restoration	Land Development/ Suburbanization	Restore Natural Flood Plain Function	Acres	6	$180,000	Remove golf course infrastructure in riparian corridor and floodplain of Chagrin, restore riparian corridor along 6,000 linear feet of Aurora Branch of Chagrin.	Assisted City of Aurora with successful WRRSP application in 2011. Construction and restoration completion expected in 2014/2015.
Beachwood - Demonstration project for University Hospital project to look at infiltration capacities of soils post development/compaction	04110003-04-02: Main Branch Chagrin River	None	Not Assessed			Prevention	Land Development/ Suburbanization	Restore Natural Flow	LF	50	$250,000	Demonstration project to look at use of equipment to rehabilitate soils that have been compacted during development and observing the stormwater infiltration capacity of soils.	Discussed with Cuyahoga SWCD Interested in moving forward
Construct innovative stormwater management BMPs to promote infiltration and restore natural flow	04110003-04-02: Main Branch Chagrin River	WWH	Partial	Direct Habitat Alterations	Flow Alteration	Prevention	Land Development/ Suburbanization	Restore Natural Flow	LF	100	$100,000	Design and construct innovative stormwater BMPs to restore natural flow and infiltration to area streams	Locations under investigation
Willoughby Hills Service Department Retrofits	04110003-04-02: Main Branch Chagrin River			Direct Habitat Alterations	Flow Alteration	Prevention	Land Development/ Suburbanization	Restore Natural Flow	LF	120	$120,000	Retrofit Service Department grounds with bioretention to restore more natural stream flow and promote infiltration	Possible SWIF funding project
Gully Brook (RM 5.5)	04110003-04-02: Main Branch Chagrin River	WWH	Not Assessed			Prevention	Land Development/ Suburbanization	Conduct Chemical Sampling	Sites	2	$10,000	OEPA noted need to sample possible salt runoff, effect of urban runoff on stream channel stability	Ohio EPA sampling scheduled for 2019
Stormwater Retrofits at Green Ridge Golf Course - Wickliffe	04110003-04-02: Main Branch Chagrin River	WWH	Not Assessed	Direct Habitat Alterations	Flow Alteration	Prevention	Land Development/ Suburbanization	Restore Natural Flow			$80,000	Retrofit Green Ridge Golf Course with bioretention and permeable pavement to treat stormwater in a tributary to Gully Brook	Application for SWIF funding in 2014, modified GLRI application in 2014, partially funded through GLRI 2015
Stormwater Retrofits at Manakiki Golf Course - Willoughby Hills/Cleveland Metroparks	04110003-04-02: Main Branch Chagrin River	WWH	Not Assessed	Direct Habitat Alterations	Flow Alteration	Restoration	Land Development/ Suburbanization	Restore Natural Flow			$450,000	Retrofit Manakiki Golf Course with bioretention, wetland detention, and restore impaired streams.	GLRI application in 2014, partially funded through GLRI 2015, seeking additional funding

Moreland Hills Service Garage Bioretention Retrofit	04110003-04-02: Main Branch Chagrin River	CWH	Full	Siltation		Prevention	Land Development/ Suburbanization	Restore Natural Flow	LF	50	$20,000	Install 650 square foot bioretention cell to improve infiltration near Moreland Hills Service Center and Village Hall, located close to two historic sites. Includes construction, planting, and signage to educate local residents and groups visiting historic sites.	Plans completed; Partially funded by NEORSD
Lang Property Stream Restoration	04110003-04-02: Main Branch Chagrin River	CWH		Direct Habitat Alterations		Restoration	Land Development/ Suburbanization	Restore Natural Flow	LF	400	$50,000	Restore 400 LF of channelized stream on Lang Property in Moreland Hills	Discussion with WRLC on grant application
Off-Street Parking	04110003-04-02: Main Branch Chagrin River	WWH	Full	Siltation		Prevention	Land Development/Suburbanization	Restore Natural Flow	LF	100	$10,000	Case study showing how parking lot design can change, highlight feasibility for municipalities, Mayfield Heights example code to modify, parking maximums, landscaping code	Developed model code update in 2013 for community review
Riparian and Wetland Protection	04110003-04-02: Main Branch Chagrin River	WWH	Partial			Prevention	Land Development/ Suburbanization	Acquire Riparian and Wetland Conservation Easements	Acres	4000	$100,000,000	Acquire additional easements on riparian corridors and wetlands.	CRWP will continue to work with local park districts, land trusts, Holden Arboretum, communities and SWCDs.
Riparian and Wetland Protection	04110003-04-02: Main Branch Chagrin River	WWH	Partial	Direct Habitat Alterations		Prevention	Land Development/ Suburbanization	Adoption of Local Conservation Statutes	Jurisdictions	12	$36,000	Riparian/wetland setbacks, erosion and sediment control, stormwater management, illicit discharge, floodplain management, conservation development and other best local land use practices	On-going CRWP goal to have 100% adoption of codes as appropriate across watershed.
Stormwater Ditch Retrofitting into Bioswales	04110003-04-02: Main Branch Chagrin River			Siltation		Prevention	Land Development/ Suburbanization	Restore Natural Flow	LF	50	$105,000	Retrofit roadside swales/ditches into bioswales ($70 per linear foot of bioswale retrofit). In City of Pepper Pike	In discussion with City of Pepper Pike
Stormwater retrofits in Orange Village	04110003-04-02: Main Branch Chagrin River			Direct Habitat Alterations	Flow Alteration	Prevention	Land Development/ Suburbanization	Restore Natural Flow	Acres	5	$200,000	Install innovative stormwater retrofits on Orange Village's new service facility to treat water quality	Successful application for SWIF funding in 2012, project completed in 2013

Mayfield Village Civic Center Stormwater Retrofits	04110003-04-02: Main Branch Chagrin River	WWH	Not Assessed	Direct Habitat Alterations	Flow Alteration	Restoration	Land Development/ Suburbanization	Restore Natural Flow	Acres	0.45	$126,500	Install innovative stormwater retrofits at Mayfield Village's Civic Center to treat water quality in Beecher's Brook	Application for SWIF funding in 2014
Ursuline College Stream Restoration	04110003-04-02: Main Branch Chagrin River			Direct Habitat Alterations	Flow Alteration	Restoration	Land Development/ Suburbanization	Restore Stream Channel	LF	1,000	$150,000	Restore 1,000 LF stream at $125/ft	In talks with Ursuline College and Pepper Pike on potential project
Ursuline College Restoration and Retrofit	04110003-04-02: Main Branch Chagrin River			Direct Habitat Alterations	Flow Alteration	Restoration	Land Development/ Suburbanization	Restore Natural Flow	LF	3,600	$300,000	Restore 1,000 LF stream and install 1600 square foot bioswale on Ursuline campus	Successful application for SWIF funding in 2012, project completion expected in 2014
Pepper Pike Administrative Retrofitting	04110003-04-02: Main Branch Chagrin River			Direct Habitat Alterations	Flow Alteration	Prevention	Land Development/ Suburbanization	Restore Natural Flow	Acres	0	$50,000	Retrofit 0.2 acres Pepper Pike Administrative Parking lot to manage stormwater runoff into Pepper/Luce Creek - permeable pavers, rain garden, resurfaced asphalt	Successful 2012 SWIF application, project completed in 2013 with permeable pavers
UT 14.88 - Pepper/Luce Creek	04110003-04-02: Main Branch Chagrin River	CWH	Full	Nutrients & Thermal Modification		Prevention	Package Plants (Small Flows)	Conduct Fish (IBI) Sampling	Sites	6	$30,000	OEPA noted need to sample	Ohio EPA sampling scheduled for 2019
UT 23.93 in Moreland Hills	04110003-04-02: Main Branch Chagrin River	None	Not Assessed			Prevention	Land Development/ Suburbanization	Conduct Fish (IBI) Sampling	Sites	2	$10,000	OEPA noted need to sample - Effluent from Quail Hollow	Ohio EPA sampling scheduled for 2019
Willey Creek (RM 26.31)	04110003-04-02: Main Branch Chagrin River	CWH	Full			Prevention	Land Development/ Suburbanization	Conduct Fish (IBI) Sampling	Sites	4	$20,000	OEPA noted need to sample	Ohio EPA sampling scheduled for 2019
Chagrin River Watershed Riparian Restoration	04110003-04-02: Main Branch Chagrin River	WWH	Partial	Direct Habitat Alterations		Restoration	Land Development/ Suburbanization	Restore Streambank Using Bio-Engineering	LF	5000	$250,000	Assist property owners with small stream bank stabilization projects, riparian corridor planting and elimination of stored materials in floodplains.	
City of Willoughby Hills: Red Fox Pass Stream Restoration	04110003-04-02: Main Branch Chagrin River	None	Not Assessed	Flow Alternation		Restoration	Land Development/ Suburbanization	Restore Stream Channel	LF	200	$50,000	Restore approximately 200 linear feet of natural stream channel on an UT to the Chagrin River.	

Gates Mills Chagrin River Mainstem Bank Stabilization Project (Old Mill Bridge north to Gates Mills Village Hall)	04110003-04-02: Main Branch Chagrin River	WWH	Full	Siltation		Restoration	Land Development/ Suburbanization	Restore Streambank Using Bio-Engineering	LF	5000	$750,000	Numerous property owners along this reach of river have erosion problems due to the sandy floodplain soils and frequent saturation. Design and construct innovative streambank erosion controls.	Have discussed potential locations for projects with Village of Gates Mills
Griswold Creek	04110003-04-02: Main Branch Chagrin River	CWH	Non	Direct Habitat Alterations		Restoration	Land Development/ Suburbanization	Restore Streambank Using Bio-Engineering	LF	2000	$200,000	Old dam structures, road crossings and hardening of streambanks have caused vertically and horizontally instability.	Secured LEPF grant in 2011 and GLBP grant in 2013. Site evaluations and survey work have been completed at 7 properties for GLBP grant and conceptual restoration designs are being developed.
Griswold Creek (RM 0.1)	04110003-04-02: Main Branch Chagrin River	CWH	Non	Direct Habitat Alterations		Restoration	Land Development/ Suburbanization	Plant Trees or Shrubs in Riparian Areas	LF	300	$10,500	Shading, thermal control, increase riparian corridor	Secured LEPF grant in 2011 and GLBP grant in 2013. Site evaluations and survey work have been completed at 7 properties for GLBP grant and conceptual restoration designs are being developed.
Griswold Creek (RM 0.1)	04110003-04-02: Main Branch Chagrin River	CWH	Non	Direct Habitat Alterations		Restoration	Land Development/ Suburbanization	Install Grade Structures	Structures	7	$700,000	Old lowhead dam structures, road crossings and hardening of streambanks have caused vertically and horizontally instability.	Secured LEPF grant in 2011 and GLBP grant in 2013. Site evaluations and survey work have been completed at 7 properties for GLBP grant and conceptual restoration designs are being developed.
Hiram House - Moreland Hills	04110003-04-02: Main Branch Chagrin River			Direct Habitat Alterations	Flow Alteration	Restoration	Flow Regulation/Modification	Restore Natural Flow	LF	1300		Restore stream tributary to Willey Creek by removing impoundment	Proposed Mitigation Site for Mitigation Bank
Hunting Valley Streambank Stabilization (West bank of the Chagrin River)	04110003-04-02: Main Branch Chagrin River	WWH	Full	Siltation		Restoration	Land Development/ Suburbanization	Restore Streambank Using Bio-Engineering	LF	4000	$1,000,000	Restore stream and riparian area to reduce NPS sedimentation	Bank stabilization and revegetation project completed along 400LF in 2012; seeking funding for additional reaches

Mapleview Lane Stream Restoration City of Willoughby Hills	04110003-04-02: Main Branch Chagrin River	WWH	Full	Flow Alternation		Restoration	Land Development/ Suburbanization	Restore Stream Channel	LF	100	$50,000	Restore approximately 100 linear feet of natural stream tributary to the Chagrin. This section of stream has a significant head cut and erosion of the channel.	Discussed with City Engineer
North Chagrin Reservation	04110003-04-02: Main Branch Chagrin River			Direct Habitat Alterations		Restoration	Drainage/Filling of Wetlands Channelization - Dev.	Reconstruct & Restore Wetlands				Restoring wetlands, reforesting, creating vernal pools through the reservation	Proposed Mitigation Site for Mitigation Bank
North Chagrin Reservation	04110003-04-02: Main Branch Chagrin River			Direct Habitat Alterations		Prevention	Land Development/ Suburbanization	Restore Natural Flow				Install stormwater retrofits to North Chagrin Reservation's Nature Center	SWIF proposal with Cleveland Metroparks
Orchard Hills Park Geauga Park District	04110003-04-02: Main Branch Chagrin River	CWH	Full	Direct Habitat Alterations	Thermal Modifications	Restoration	Flow Regulation/Modification	Restore Stream Channel	LF	800	$380,000	Restore and enhance main tributary and riparian wetlands to Caves Creek. Includes design/engineering, restoration, and post restoration monitoring.	WRRSP and 319 funded Phase I restoration project completed in fall 2010, Phase II reforestation still underway
Orchard Hills Park Geauga Park District	04110003-04-02: Main Branch Chagrin River	CWH	Full	Direct Habitat Alterations	Thermal Modifications	Restoration	Flow Regulation/Modification	Reconstruct & Restore Wetlands	Acres	5.5	$165,000	Restore and enhance tributary and riparian wetlands to Caves Creek. Includes design/engineering, restoration, and post restoration monitoring.	WRRSP and 319 funded Phase I restoration project completed in fall 2010, Phase II reforestation still underway
Orchard Hills Park Geauga Park District and Waste Management Property	04110003-04-02: Main Branch Chagrin River	CWH	Full	Flow Alternation		Restoration	Land Development/ Suburbanization	Land Development/Suburbanization	Restore Stream Channel	LF	$1,045,000	Restore and enhance 2,200 LF of tributary to Caves Creek. Design/engineering, restoration, and monitoring.	
Pleasant Valley Park	04110003-04-02: Main Branch Chagrin River	WWH	Full	Flow Alternation		Restoration	Land Development/ Suburbanization	Restore Natural Flood Plain Function	Acres	10	$290,000	Feasibility study, engineering and construction for floodplain and stream restoration on the north side of Pleasant Valley Road. Project would involve removal of fill along the 1,150 linear feet State Scenic Chagrin River. This project is downstream of proposed 319 grant application submitted in 2009	319 application approved for downstream project to restore 4.5 acres wetland, 17 acres of riparian corridor, and remove 650 feet of levees along the Chagrin River; project completed in 2012

Sulphur Springs Restoration	04110003-04-02: Main Branch Chagrin River	CWH	Full	Thermal Modifications	Flow Alteration	Restoration	Land Development/ Suburbanization	Conduct Habitat (QHEI or HHEI) Sampling	Sites	6	$46,000	Monitor stream flow, temperature, and habitat for potential brook trout habitat and to focus possible stormwater retrofits where needed.	GLBFHP funding secured in 2012, monitoring ongoing with Cleveland Metroparks
Sulphur Springs Restoration	04110003-04-02: Main Branch Chagrin River	CWH	Full	Thermal Modifications	Flow Alteration	Restoration	Land Development/ Suburbanization	Restore Streambank Using Bio-Engineering	LF	400	$40,000	Restore section of stream in South Chagrin Reservation where an old impoundment existed	GLBFHP funding secured in 2012, stream restoration completed in 2013
Stormwater Reuse at Woodmere Service Facility	04110003-04-02: Main Branch Chagrin River	CWH	Not Assessed	Direct Habitat Alterations	Flow Alteration	Prevention	Land Development/ Suburbanization	Restore Natural Flow	SF		$75,000	Install permeable pavers and rainwater harvesting system at Woodmere's Service Facility to capture stormwater before it enters the headwaters of Willey Creek	SWIF application in 2014
Shiverick Floodplain Reforestation(Village of Hunting Valley along Chagrin River Road)	04110003-04-02: Main Branch Chagrin River	WWH	Full	Direct Habitat Alterations		Restoration	Land Development/ Suburbanization	Plant Trees or Shrubs in Riparian Areas	Acres	6	$30,000	Restore 6 acres of floodplain forest along State Scenic Chagrin River.	
Assistance to schools, communities and residents to apply for stormwater credits in local stormwater utilities	04110003-04-01: East Branch Chagrin River	CWH	Partial	Flow Alteration		Prevention	Land Development/ Suburbanization	Restore Natural Flow	LF	600	$600,000	Install Stormwater BMPs to restore nature stream flow and infiltration capacities and allow property owners to obtain credits from local stormwater utilities	Lake SMD has a credit manual. CRWP will work with LSMD to increase usage of credits.
Construct innovative stormwater management BMPs to promote infiltration and restore natural flow	04110003-04-01: East Branch Chagrin River	CWH	Partial	Direct Habitat Alterations	Flow Alteration	Prevention	Land Development/ Suburbanization	Restore Natural Flow	LF	100	$100,000	Design and construct innovative stormwater BMPs to restore natural flow and infiltration ot area streams	Locations under investigation
Baldwin Road Bioretention Project	04110003-04-01: East Branch Chagrin River	CWH	Not Assessed	Direct Habitat Alterations	Flow Alteration	Prevention	Land Development/ Suburbanization	Restore Natural Flow	LF	100	$100,000	Install bioretention along Baldwin Road to restore natural flow and infiltration	Successful SWIF application in 2012, project construction completed 2013 with final planting in 2014

City of Kirtland Municipal Complex Retrofit	04110003-04-01: East Branch Chagrin River	CWH	Not Assessed	Direct Habitat Alterations	Flow Alteration	Prevention	Land Development/ Suburbanization	Restore Natural Flow	LF	100	$100,000	Install innovative stormwater BMPs at the City of Kirtland municipal complex	In discussion with City of Kirtland
Holden Arboretum Parking Lot Reconfiguration	04110003-04-01: East Branch Chagrin River	CWH	Full	Siltation		Prevention	Land Development/ Suburbanization	Restore Natural Flow	LF	100	$2,500,000	Retrofit current parking bays. Remove Sassafras Pond,replace this wetland with large rain gardens. Bioswales, rain gardens will filter associated pollutants before water discharges into tributaries of Pierson Creek	Worked with Holden Arboretum to complete construction of bioretention cells in Visitor Parking Lot in 2013.
Penitentiary Glen Parking Lot Retrofits	04110003-04-01: East Branch Chagrin River	CWH	Not Assessed	Direct Habitat Alterations	Flow Alteration	Prevention	Land Development/ Suburbanization	Restore Natural Flow	LF	100	$100,000	Install bioretention at Penitentiary Glen parking lot to help promote infiltration, restore natural flow and reduce thermal pollution to CWH stream	No Plans
Lake Farmpark Parking Lot Retrofit	04110003-04-01: East Branch Chagrin River	CWH	Partial	Siltation		Prevention	Land Development/ Suburbanization	Restore Natural Flow	LF	200	$275,000 (6 ac/sf)	Retrofit existing parking lot using Grasspave or geogrid similar grassy pavers to minimize impervious cover, promote infiltration in UT to East Branch at RM 14.8. Upper bay of parking is approximately 1 acre	In discussion with Lake Metroparks
Riparian and Wetland Protection	04110003-04-01: East Branch Chagrin River	CWH	Partial			Prevention	Land Development/ Suburbanization	Acquire Riparian and Wetland Conservation Easements	Acres	2000	$50,000,000	Acquire additional easements on riparian corridors and wetlands.	CRWP will continue to work with local park districts, land trusts, Holden Arboretum, communities and SWCDs.
Riparian and Wetland Protection	04110003-04-01: East Branch Chagrin River	CWH	Partial			Prevention	Land Development/ Suburbanization	Adoption of Local Conservation Statutes	Jurisdictions	8	$24,000	Riparian and and wetland setbacks, erosion and sediment control, stormwater management, illicit discharge, floodplain management, conservation development and other best local land use practices	On-going CRWP goal to have 100% adoption of codes as appropriate across watershed.

Falling Waters Subdivision Munson Twp	04110003-04-01: East Branch Chagrin River	CWH	Not Assessed			Protection	Land Development/ Suburbanization	Acquire Riparian Conservation Easements	LF	1000	$120,000	Preserve high quality stream on Hidden Ridge Drive subdivision	Proposed Mitigation Site for Mitigation Bank
Stoney Brook (Trib. to E. Br. at RM 3.57)	04110003-04-01: East Branch Chagrin River	CWH	Partial	Nutrients		Restoration	Package Plants (Small Flows)	Replace numerous package plants with Central Sewer	Package Plants	14	$3,000,000		Construction planned for 2010.
Trib to E. Br. Chagrin R. (RM 14.80)	04110003-04-01: East Branch Chagrin River	CWH	Partial	Siltation	Direct Habitat Alterations	Restoration	Land Development/ Suburbanization	Restore Stream Channel	LF	250	$37,500	Restore stream at road crossing to allow fish passage	No Plans
Trib. To E. Br. Chagrin R. (RM 15.35)	04110003-04-01: East Branch Chagrin River	CWH/EWH	Partial/Non	Siltation	Direct Habitat Alterations	Restoration	Land Development/ Suburbanization	Restore Stream Channel	LF	350	$52,500	Restore stream at bridge to allow fish passage	No Plans
Chagrin River Watershed Riparian Restoration	04110003-04-01: East Branch Chagrin River	CWH	Partial	Direct Habitat Alterations		Restoration	Land Development/ Suburbanization	Restore Streambank Using Bio-Engineering	LF	5000	$250,000	Assist property owners with small stream bank stabilization projects, riparian corridor planting and elimination of stored materials in floodplains.	
East Branch Chagrin River (RM 10.3-16.3)	04110003-04-01: East Branch Chagrin River	CWH	Partial	Direct Habitat Alterations	Siltation	Restoration	Land Development/ Suburbanization	Restore Streambank Using Bio-Engineering	LF	1000	$100,000	Restore stream banks where eroded to minimize sedimentation.	No Plans
East Branch Chagrin River (RM 2.4)	04110003-04-01: East Branch Chagrin River	CWH	Non	Direct Habitat Alterations	Siltation	Restoration	Dredge Mining	Restore Stream Channel	LF	10000	$1,500,000	Restore stream through Kirtland Hills, partially under orders from Ohio EPA.	Stream restoration underway by Kirtland Hills
Holden Arboretum Corning Lake Restoration	04110003-04-01: East Branch Chagrin River	CWH	Full	Direct Habitat Alterations	Thermal Modifications	Restoration	Flow Regulation/Modification	Reconstruct & Restore Wetlands	Acres	2	$295,000	Dredge/reconfigure shoreline and profile of Corning Lake. Cement overflow system will be removed, new riparian corridor will be restored in what appears to be the historical outflow. Newly designed riparian area will slow down/cool the water before entering Pierson Creek. Wetlands adjacent to east and north of Corning Lake will be enlarged / enhanced	Successful SWIF application in 2013 to restore cement channel, working with Holden to complete restoration in 2014.

Holden Creeks Project	04110003-04-01: East Branch Chagrin River	CWH	Full	Direct Habitat Alterations	Thermal Modifications	Restoration	Flow Regulation/Modification	Restore Stream Channel	LF	2000	$400,000	Corning Lake feeds two ponds before entering tributaries of Pierson Creek. Holden intends to reconfigure two ponds, Lotus Pond and Foster Pond, using natural stream channel design to provide increased ecological services; reduce erosion by slowing water flow, release cleaner and cooler water	In discussion with Holden Arboretum
Holden Watershed Daylight Project	04110003-04-01: East Branch Chagrin River	CWH	Full	Flow Alternation	Thermal Modifications	Restoration	Land Development/ Suburbanization	Restore Stream Channel	LF	2000	$400,000	Daylight buried stream, currently carries all stormwater from gravel overflow parking lot and associated wetland. Associated wetland will be expanded/enhanced becoming important landscape feature.	
Restoration East Branch along State Route 84	04110003-04-01: East Branch Chagrin River	CWH	Partial	Siltation	Thermal Modifications	Restoration	Land Development/ Suburbanization	Restore Streambank Using Bio-Engineering	LF	1500	$350,000	Located just upstream of Daniel's Park Dam East Branch is experiencing extreme erosion in this area due to downcutting from dam breach and along I-90 corridor. Includes design and construction of stream bank stabilization, will vertically stabilize area, and remove historic water intake structures located in river bed.	
Riverwood Project (three parcels owned by Holden Arboretum, two east side of Wisner Road, one west side Wisner Road, all north of State Route 6)	04110003-04-01: East Branch Chagrin River	CWH	Full	Flow Alternation		Restoration	Land Development/ Suburbanization	Restore Stream Channel	LF	300	$367,500	Restore natural drainage patterns and floodplain function on East Branch through restoration of 550 linear feet of degraded headwater streams, 275 linear feet of stream bank restoring river access to the former floodplain, reclaim 1 acre of restored floodplain with forest.	Restoration construction completed through 319 funding in 2013, final planting in 2014

Roudebush Project - Holden Arboretum	04110003-04-01: East Branch Chagrin River	CWH	Not Assessed	Direct Habitat Alterations	Thermal Modifications	Restoration	Flow Regulation/Modification	Restore Stream Channel	LF	1500	$675,000	Complete purchase of land, remove function of 2 existing dams. Convert upstream pond into 3 acre emergent wetland. Downstream pond restored into 1,500 linear feet of stream using natural stream channel design. Stebbins' Gulch which feeds into East Branch of Chagrin.	
Strong Acres -Kirtland Holden Arboretum	04110003-04-01: East Branch Chagrin River	CWH	Not Assessed	Flow Alteration		Restoration	Upstream Impoundment	Restore Natural Flow	LF/Ac	1150/ 0.33		Previous herbaceous meadow needs to have drain tile and pond removed and restored to its natural hydrology	Proposed Mitigation Site for Mitigation Bank
Weaver Project (Holden Arboretum, City of Kirtland Located on three parcels at the intersection of State Route 6 and Sperry Road	04110003-04-01: East Branch Chagrin River	CWH	Not Assessed	Direct Habitat Alterations		Restoration	Land Development/ Suburbanization	Plant Trees or Shrubs in Riparian Areas	Acres	$3	$75,000	Funding for Holden to purchase the property. Restoration of 3 acres of the property in part to forest.	
Construct innovative stormwater management BMPs to promote infiltration and restore natural flow	04110003-04-03: Lower Chagrin River	WWH	Partial	Direct Habitat Alterations	Flow Alteration	Prevention	Land Development/ Suburbanization	Restore Natural Flow	LF	100	$100,000	Design and construct innovative stormwater BMPs to restore natural flow and infiltration to area streams	Locations under investigation
Todd Field Bendway Weirs Project	04110003-04-03: Lower Chagrin River	WWH	Full	Direct Habitat Alterations		Restoration	Land Development/ Suburbanization	Restore Stream Channel	LF	880	$110,000	Restore section of Chagrin River main stem at Todd Field in City of Willoughby	Successful 319 application in 2012, construction expected in 2014
Lost Nation Golf Course Stream Restoration	04110003-04-03: Lower Chagrin River	WWH	Non	Direct Habitat Alterations		Restoration	Land Development/ Suburbanization	Restore Streambank Using Bio-Engineering	LF	1,250	$150,000	Restore section of nonattaining Ward/Newell Creek through Lost Nation Golf Course	Restoration completed in 2013 through GLRI funding
Lost Nation Golf Course Stormwater Retrofits	04110003-04-03: Lower Chagrin River	WWH	Non	Direct Habitat Alterations	Flow Alteration	Restoration	Land Development/ Suburbanization	Restore Natural Flow	Structures	2	$80,000	Install 2 rainwater harvesting cisterns at Lost Nation Golf Course to hold approximately 11,000 gallons of stormwater that would otherwise enter Ward Creek untreated	SWIF application in 2014

Riparian and Wetland Protection	04110003-04-03: Lower Chagrin River	WWH	Partial			Prevention	Land Development/ Suburbanization	Acquire Riparian and Wetland Conservation Easements	Acres	50	$1,250,000	Acquire additional easements on stream and islands at mouth of the Chagrin. North Island is approximately 11 acres of the island comprised of 30 parcels.	CRWP will continue to work with Lake Metroparks, Eastlake Port Authority and Lake County Coastal Plan
Riparian and Wetland Protection	04110003-04-03: Lower Chagrin River	WWH	Partial			Prevention	Land Development/ Suburbanization	Adoption of Local Conservation Statutes	Jurisdictions	5	$15,000	Riparian and wetland setbacks, erosion and sediment control, stormwater management, illicit discharge, floodplain management, conservation development and other best local land use practices	On-going CRWP goal to have 100% adoption of codes as appropriate across watershed.
Chagrin River Watershed Riparian Restoration	04110003-04-03: Lower Chagrin River	WWH	Partial	Direct Habitat Alterations		Restoration	Land Development/ Suburbanization	Restore Streambank Using Bio-Engineering	LF	5000	$250,000	Assist property owners with small stream bank stabilization projects, riparian corridor planting and elimination of stored materials in floodplains.	
Corporation Creek Floodplain Restoration-City of Eastlake (Becker Court, Cove Court, and Erie Road)	04110003-04-03: Lower Chagrin River	EWH	Not Assessed	Flow Alternation		Restoration	Land Development/ Suburbanization	Restore Natural Flood Plain Function	Acres	1	$110,000	Restore 1,000 linear feet of Corporation Creek and associated floodplain through existing industrial park.	
Floodplain Restoration on Newell Creek City of Mentor	04110003-04-03: Lower Chagrin River	WWH	Non	Flow Alteration	Siltation	Restoration	Urban Runoff/Storm Sewers (NPS)	Restore Natural Flood Plain Function	Acres	2	$70,000	Restore floodplain on Newell Creek, behind Clairidge House Apartments. Stream overflows and floods garages and parking lot area for the apartments. Widen floodplain area on north side of the stream, plant native floodplain vegetation.	Discussed with City Engineer and performed site visit with SWCD
Stormwater Quality Enhancements for Garfield Park Pond - Mentor	04110003-04-03: Lower Chagrin River	WWH	Non	Flow Alteration	Siltation	Restoration	Urban Runoff/Storm Sewers (NPS)	Restore Natural Flow	LF	1000	$500,000	Garfield Pond receives approximately 1,500 acres of drainage. Sediment in pond has built up, reduced the water depth to 1 to 2 feet. Pond needs dredged to depth of 4 to 6 feet & establish aquatic shelf around perimeter.	

Stormwater retrofits at President's Park Pond-City of Mentor	04110003-04-03: Lower Chagrin River	WWH	Non	Flow Alteration	Siltation	Restoration	Urban Runoff/Storm Sewers (NPS)	Restore Natural Flow	LF	500	$200,000	Provides stormwater retention for watershed of approximately 3,500 acres. Pond at President's Park is in Newell creek watershed. Modify outlet to provide extended detention and construct aquatic benches constructed to improve water quality.	
Ward Creek	04110003-04-03: Lower Chagrin River	WWH	Non	Flow Alteration	Siltation	Restoration	Urban Runoff/Storm Sewers (NPS)	Restore Stream Channel	LF	2500	$500,000	Restore stream through City of Eastlake to mouth	Much of area is owned by local governments and designated as PCA in BG Plan.
Water Quality Enhancements at Great Lakes Mall - Newell Creek	04110003-04-03: Lower Chagrin River	WWH	Non	Flow Alteration	Siltation	Restoration	Urban Runoff/Storm Sewers (NPS)	Restore Natural Flow	LF	1000	$500,000	Water quality enhancements including constructing bio-retention areas around existing inlet locations and bio-retention swales adjacent to drive/roadway improvements. Additional green space, stormwater retention to reduce overall amount of runoff from site.	Successful GLRI application in 2011, working with City of Mentor and Great Lakes Mall owners, exploring other possible sites for retrofit

15 Implementation of Ohio Coastal Nonpoint Pollution Control Program Management Measures

In accordance with Appendix 8 of *A Guide to Developing Local Watershed Action Plans in Ohio*, the following identifies implementation strategies for the Management Measures of the Ohio Coastal Nonpoint Pollution Control Program (OCNP) in the Chagrin River watershed. Management measures identified in the OCNP that are applicable to the Chagrin River Ohio Lake Erie watershed include:

Urban:
- New Development
- Watershed Protection
- Site Development
- Existing Development
- New On-Site Disposal Systems
- Operating On-Site Disposal Systems
- Planning, Siting and Developing Roads and Highways (Local Only)
- Bridges (Local Only)
- Operation and Maintenance of Roads, Highways and Bridges
- Runoff Systems for Roads, Highways and Bridges

Hydromodification:
- Operation & Maintenance Program for Existing Modified Channels - protect surface water
- Operation & Maintenance Program for Existing Modified Channels - restore instream & riparian habitat
- Dams – Protection of Surface Water Quality and Instream and Riparian Habitat
- Eroding Streambanks and Shorelines

Each of these Management Measures, implementation strategies programs and lead agencies are detailed below. Each Sixty-seven percent (67%) of the watershed is in communities designated under Ohio EPA's NPDES Phase II Stormwater Management requirements and are exempt from the following Urban Management Measures:
- New Development
- Existing Development
- Operation and Maintenance of Roads, Highways and Bridges
- Runoff Systems for Roads, Highways and Bridges

The communities designated under Phase II are detailed in

Table 2 and
Table 3.

15.1 Urban Management Measures

15.1.1 New Development, Watershed Protection, Site Development; and Existing Development

The primary mechanism for controlling stormwater, erosion and sediment control and impacts on aquatic resources during development are local development codes. CRWP works with Member communities and local partners for communities to adopt best local land use practices. These practices and the number of Chagrin communities adopting are detailed below (note there are a total of 32 communities with local land use authority in the Chagrin watershed):

- **Land Use Planning:** 100% of Chagrin communities have a comprehensive land use plan
- **Riparian and Wetland Setbacks** – 14 (44%) Chagrin communities
- **Erosion and Sediment Control** – 23 (72%) Chagrin communities
- **Comprehensive Stormwater Management** – 23 (72%) Chagrin communities
- **Conservation Development** with a minimum of 40% open space – 9 (28%) Chagrin communities

CRWP has developed model zoning regulations for the above codes that provide protection of existing resources while developing. CRWP will continue to work with local communities, SWCDs, county planning commissions for adoption and implementation of these codes. Projects and actions for working with communities to adopt additional best local land use practices are detailed in Table 35. In addition, the *Chagrin River Watershed Balanced Growth Plan* linked in Appendix A details Priority Conservation and Development Areas as well as implementation measures for each community which will assist to guide new development. Finally, CRWP is working to develop a CRWP Mitigation Bank to ensure any impacts to water resources are mitigated within the watershed.

15.1.2 Existing Development

To protect or improve surface water quality by reducing surface water runoff and preserving and enhancing existing aquatic resources, a combination of local land use codes, stormwater retrofits, and restoration are needed. CRWP's model code for comprehensive stormwater management which has been adopted by 72% of the communities in the watershed includes provisions for managing stormwater when properties are being redeveloped. In addition, CRWP is exploring numerous opportunities for stormwater retrofits and stream, floodplain, and wetland restoration to protect aquatic resources and restore them to their predevelopment condition. Table 35 details numerous projects in each 12 digit HUC that would implement this management measure. For more developed communities, the *Chagrin River Watershed Balanced Growth Plan* (Appendix A) highlights Priority Conservation and Development Areas that may focus on redevelopment opportunities and the need to perform work in existing developed areas in a manner than improves stormwater management and protects and restores aquatic resources.

15.1.3 New On-Site Disposal Systems

The purpose of this management measure is to protect the Chagrin River watershed from pollutants discharged by new onsite disposal systems. County health departments already incorporate regulations that require new systems to consider local soil conditions, lot size, and the design and type of system. These programs vary throughout the watershed. Adoption of statewide standards for HSTS would greatly assist to standardize the development of new onsite systems in the Chagrin watershed. CRWP will continue to coordinate with local community engineers, Geauga County Water Resources, county health departments, NEORSD, and Ohio EPA on the location and management of any new disposal systems.

15.1.4 Operating On-Site Disposal Systems

CRWP will continue to work with local health departments to develop and implement HSTS plans, point of sale, and other inspection programs to identify problem systems and repair or replace these systems. In many areas of Cuyahoga County existing systems are being eliminated through the expansion of sanitary sewer projects. Further in Kirtland, fourteen package plants will be tied into a sanitary sewer line along State Route 306 which will minimize flows and effectively treat wastewater. As with new onsite disposal systems, new statewide regulations and standards would be beneficial in the Chagrin River watershed.

15.1.5 Planning, Siting and Developing Roads and Highways and Bridges(Local Only)

The best time to address control of NPS pollution from roads and highways is during the initial planning and design phase. New roads and highways should be located with consideration of natural drainage patterns and planned to avoid encroachment on surface waters and wet areas. CRWP's model codes for erosion and sediment control, comprehensive stormwater management and riparian setbacks which have been adopted by 72% and 44% of the communities in the watershed, respectively, require that the planning and development of roads consider management of sediment, stormwater, and consider location of aquatic resources. In addition, CRWP is working to develop a CRWP Mitigation Bank to ensure any impacts to water resources are mitigated within the watershed. CRWP will continue to work with local communities, SWCDs, county planning commissions for adoption and implementation of these codes and identification of possible mitigation sites.

15.1.6 Operation and Maintenance of Roads, Highways and Bridges

Incorporate pollution prevention procedures into the operation and maintenance of roads, highways, and bridges to reduce pollutant loadings to surface waters. CRWP's model codes for erosion and sediment control and comprehensive stormwater management which have been adopted by 72% of the communities in the watershed require inspections during construction to ensure erosion and sediment control measures are implemented and maintenance plans for any post construction stormwater BMPs. In addition local stormwater management agencies, Lake Stormwater Management Department and Northeast Ohio Regional Sewer District, will develop programs to require inspections during construction and long term maintenance of infrastructure. In Geauga County, drainage maintenance districts are created for each new residential subdivisions to ensure funding is available for long term operation and maintenance. CRWP will continue to work with local communities, SWCDs, county planning commissions for adoption and implementation of these codes.

15.1.7 Runoff Systems for Roads, Highways and Bridges

Develop and implement runoff management systems for existing roads, highways, and bridges to reduce runoff pollutant concentrations and volumes entering surface waters. CRWP's model code for comprehensive stormwater management which has been adopted by 72% of the communities in the watershed includes provisions for managing stormwater when properties are being redeveloped. In addition, CRWP is exploring numerous opportunities for stormwater retrofits and stream, floodplain, and wetland restoration to protect aquatic resources and restore them to their predevelopment condition. Table 35 details numerous projects in each 12 digit HUC that would implement this management measure.

15.2 Hydromodification Management Measures

15.2.1 Operation & Maintenance Program for Existing Modified Channels - protect surface water

The purpose of this management measure is to ensure that the planning process for new hydromodification projects addresses changes to physical and chemical characteristics of surface waters that may occur as a result of the proposed work. There are no programs for maintaining existing modified channels in the Chagrin watershed. All modified channels will be targeted for restoration as noted in Table 35.

15.2.2 Operation & Maintenance Program for Existing Modified Channels - restore instream & riparian habitat

CRWP regularly works with property owners, park districts, local communities, and SWCDs on restoring instream and riparian habitats. Specifically CRWP is focused on restoration projects as noted in Table 35 and any restoration projects on streams not meeting their designated aquatic life uses as shown in Table 7.

15.2.3 Dams – Protection of Surface Water Quality and Instream and Riparian Habitat

Most of the dams in the Chagrin River watershed are relatively small and were created for recreational purposes. A few remnant industrial use dams in the watershed have been converted to recreational purposes. As noted in Section 10.15 and Table 35, all dams in the watershed will be evaluated for removal and restoration. Previous dam removals and restorations include Silver Creek and Upper IVEX dams. The IEX Lower Dam and Kenston Lake dam modification, removal, and stream restoration projects in currently in the design stage. CRWP will continue to work with dam owners, local communities, ODNR Dam Safety to evaluate and improve water quality near dams.

15.2.4 Eroding Streambanks and Shorelines

Streambank erosion is a concern throughout the Chagrin River watershed and is a target in all seven 12 digit HUC as detailed in Table 35. Previous stabilization projects include tree revetments constructed by both CRWP and Lake SWCD. CRWP will continue to work with local communities, individual property owners, and SWCDs on recommendations for streambank erosion projects.

Many of the strategies to implement the Ohio Coastal Nonpoint Pollution Control Program Management Measures have already been completed. However, the implementation and maintenance of those practices is important for the long term control of sediment, nutrients, and bacteria within the Chagrin River watershed. CRWP will continue to partner with agencies detailed in Sections 10 and 7.4 to complete these management measures and implement the projects detailed in Table 35.

16 Evaluation

Evaluation is a necessary step in a watershed planning process. CRWP will assume tracking of the Chagrin River Watershed Action Plan implementation progress by capturing and documenting all activities undertaken in the plan. Close communication, through CRWP Board Meetings, watershed stakeholders meetings (as needed) will ensure that activities are documented appropriately. CRWP will communicate the annual results and updates of plan activities through the CRWP web site, annual work plans, and semi-annual technical reports and implementation reports to ODNR and Ohio EPA.

CRWP will annually track progress of the watershed plan goals and tasks and evaluate the effectiveness of all watershed activities and determine when unsatisfactory progress will lead to plan revisions.

17 Plan Update and Revision

Formal revisions to the plan will be made when necessary. Additional interim plan amendments will be made if important opportunities exist, as new data becomes available, and new goals or revision to goals becomes necessary. Goals and associated timeframes will be evaluated and revised if not met. The amendments will be developed by CRWP, reviewed by the stakeholders and forwarded to Ohio EPA and ODNR. A major revision of the *Plan* was completed in December 2009. Periodically the Plan will be revised and the most recent edition will be posted on CRWP's website http://www.crwp.org.

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Appendix A Chagrin River Watershed Balanced Growth Plan

This Plan is included in a separate document, endorsed by the Ohio Lake Erie Commission on September 28, 2009. The most recent version of the *Chagrin River Watershed Balanced Growth Plan* is available at http://www.crwp.org/Projects/crwp_bgi_plan.htm.

Preparation of the *Chagrin River Watershed Balanced Growth Plan* and associated materials and data was funded by a grant from the Ohio Lake Erie Commission, Ohio Water Development Authority, Cooperative Institute for Coastal and Estuarine Environmental Technology (CICEET), and CRWP members. CICEET is a partnership of the National Oceanic and Atmospheric Administration and the University of New Hampshire.

Priority Conservation and Development Area Maps for 12 digit HUC Watersheds, excerpted from *Chagrin River Watershed Balanced Growth Plan*:

- Town of Willoughby-Chagrin River (Lower Branch of Chagrin River)
- East Branch-Chagrin River (East Branch of Chagrin River)
- Griswold Creek-Chagrin River (Main Stem of Chagrin River)
- Beaver Creek-Chagrin River (Upper Main Branch of Chagrin River)
- Silver Creek
- McFarland Creek-Aurora Branch (Lower Aurora Branch and McFarland Creek)
- Headwaters Aurora Branch (Upper Aurora Branch)

Figure 76: Town of Willoughby-Chagrin River Priority Conservation and Development Areas

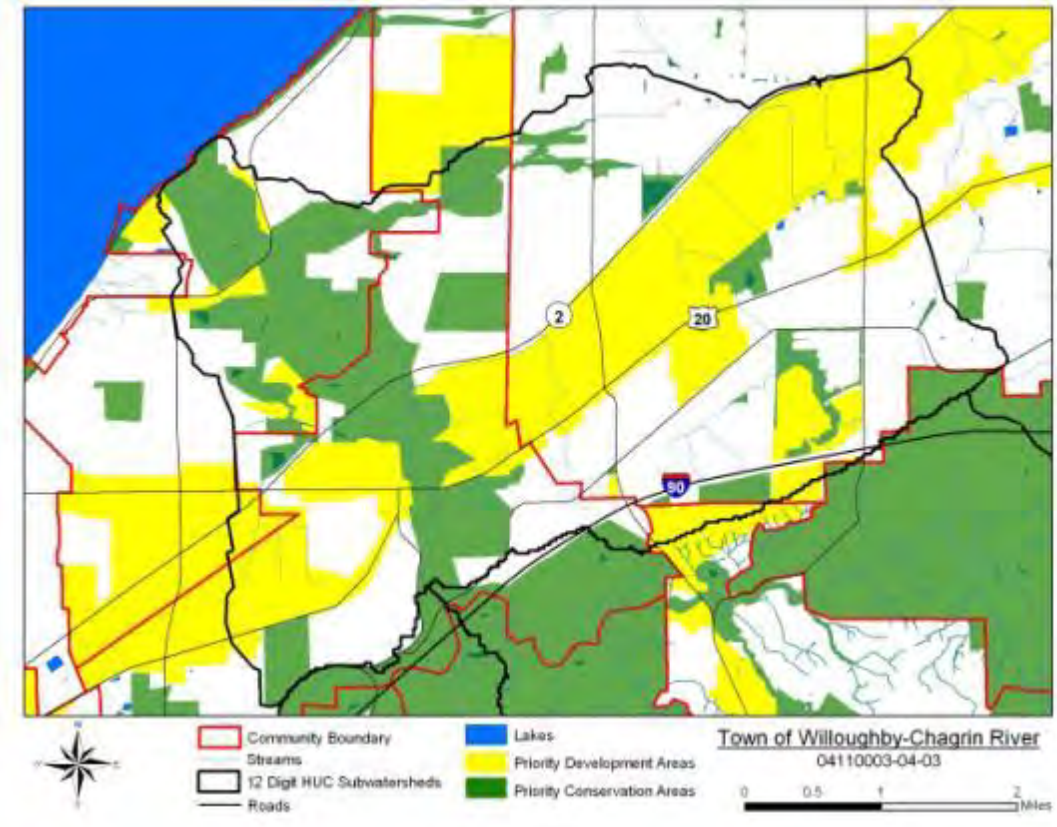


Figure 77: East Branch-Chagrin River Priority Conservation and Development Areas

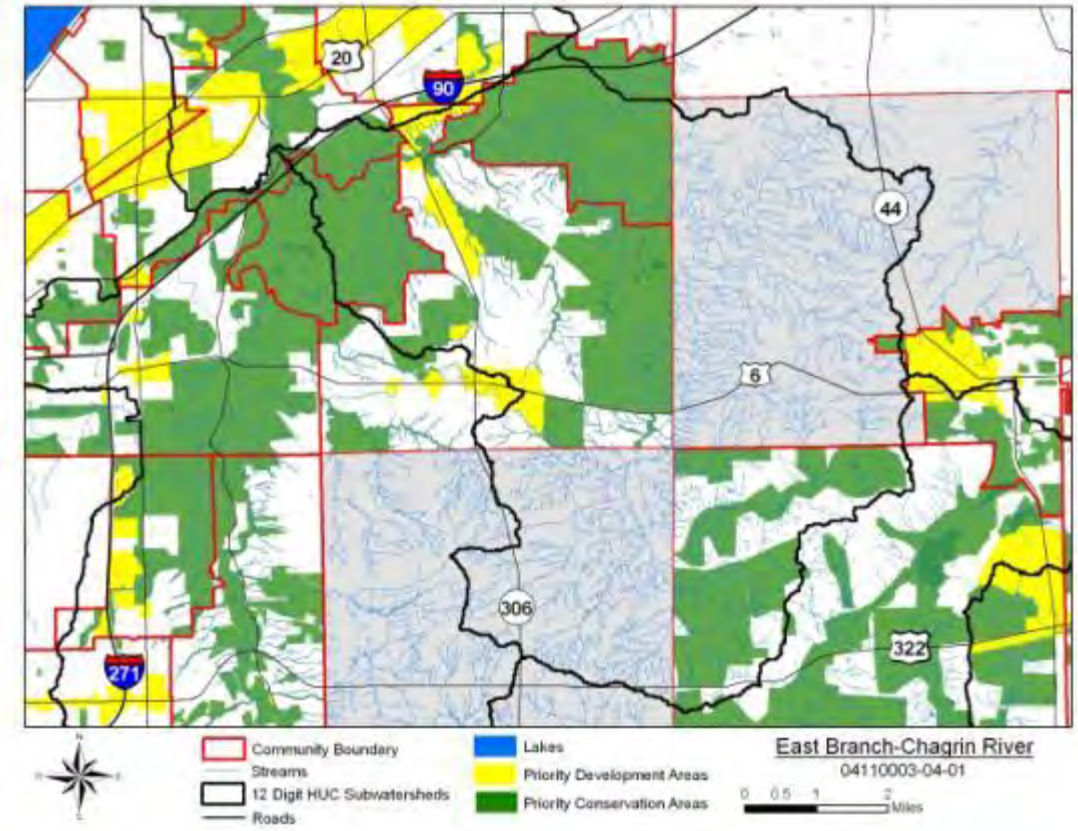


Figure 78: Griswold Creek-Chagrin River Priority Conservation and Development Areas

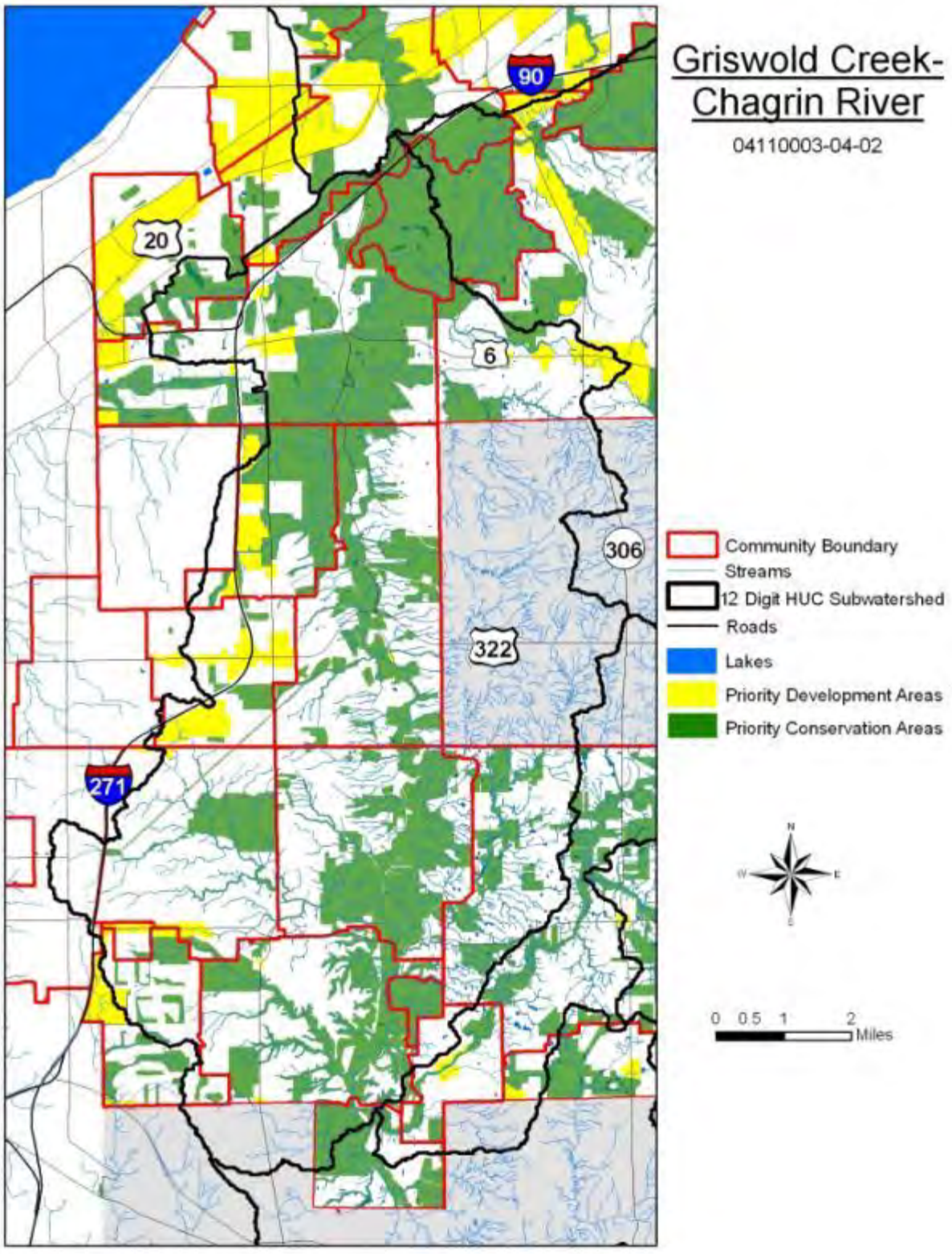


Figure 79: Beaver Creek-Chagrin River Priority Conservation and Development Areas

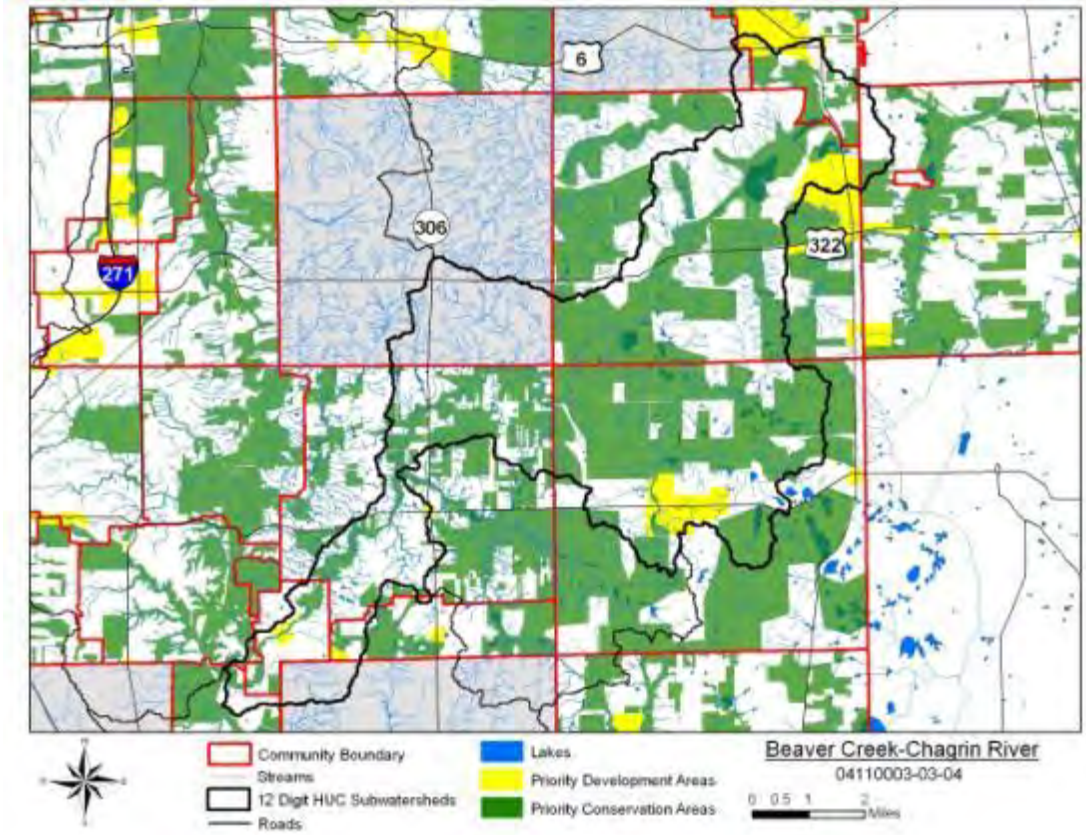


Figure 80: Silver Creek Priority Conservation and Development Areas

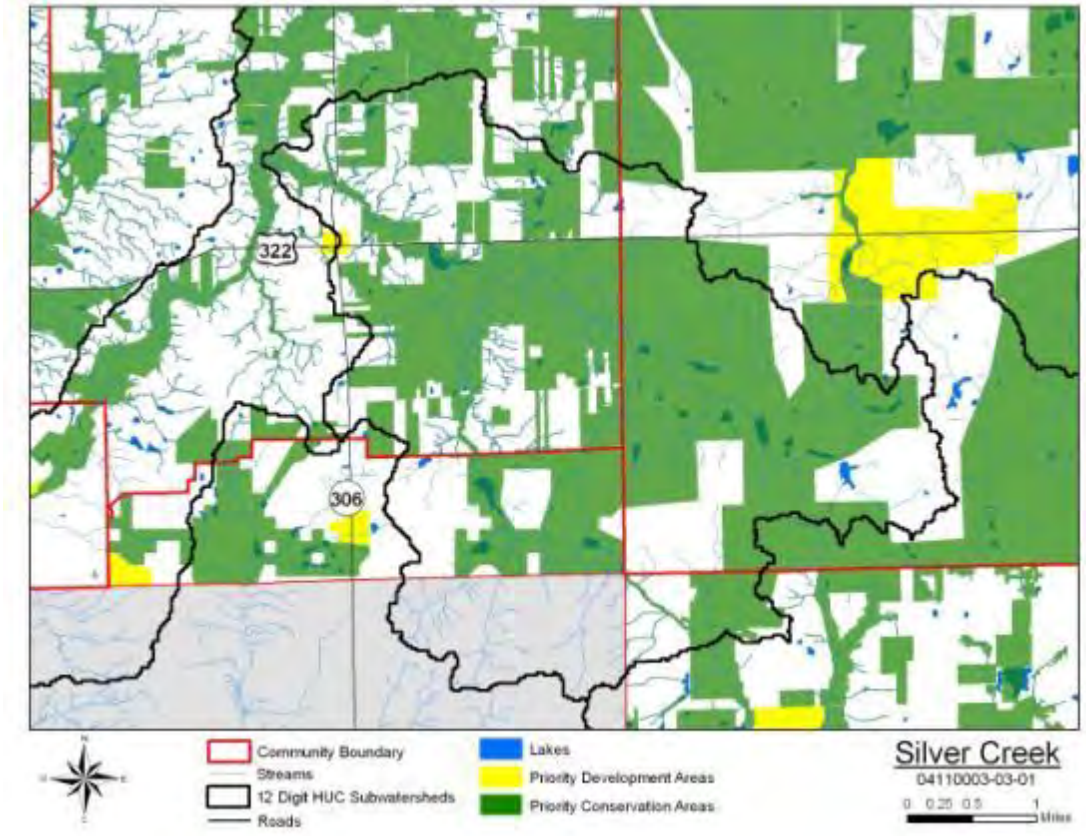


Figure 81: McFarland Creek-Aurora Branch Priority Conservation and Development Areas

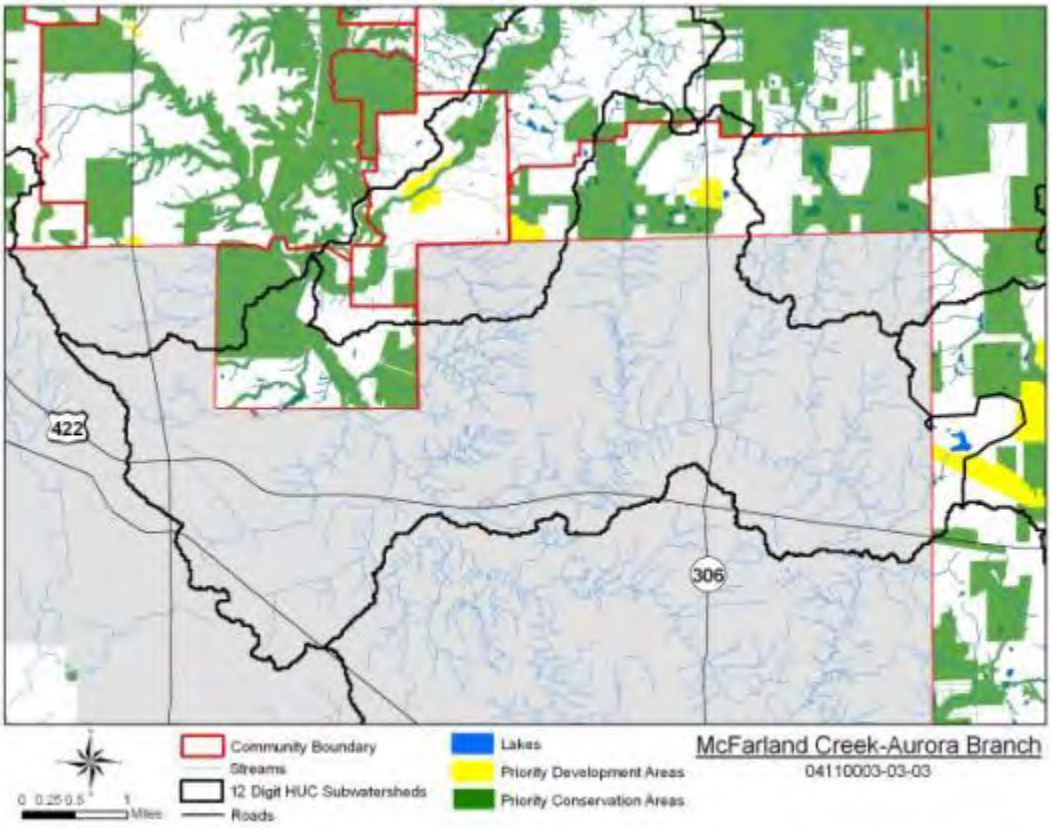
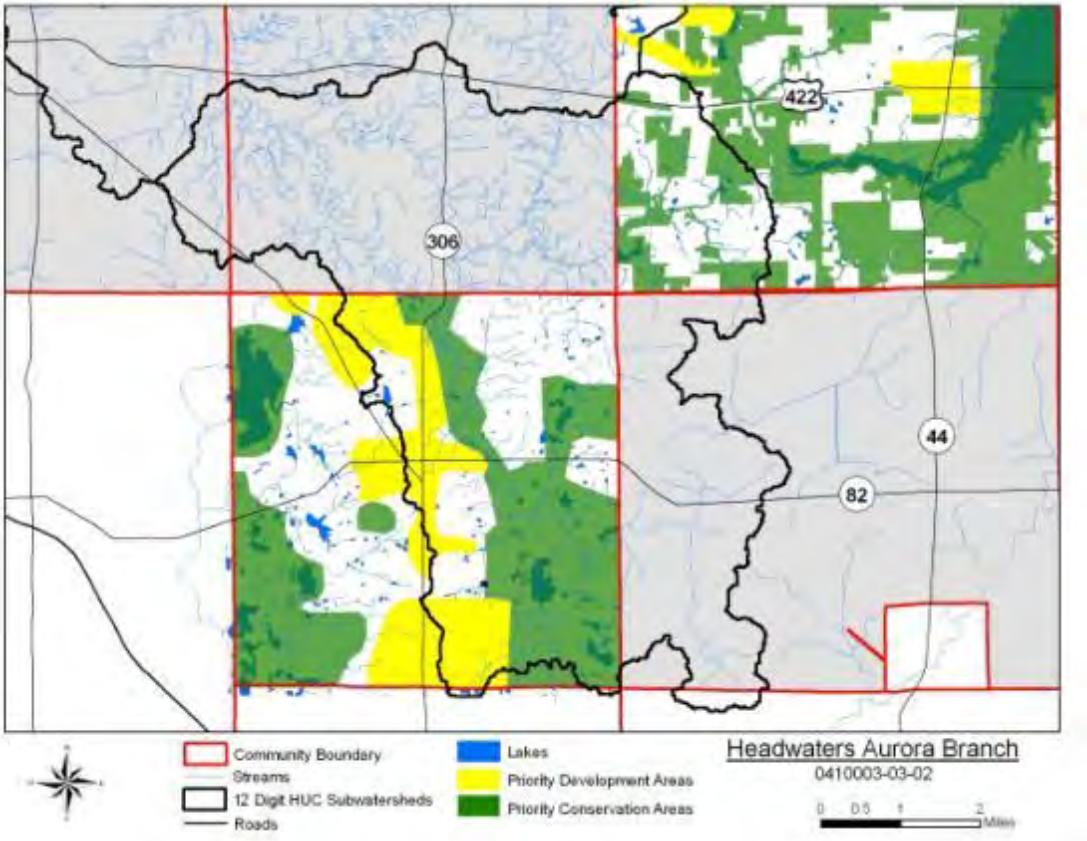


Figure 82: Headwaters Aurora Branch Priority Conservation and Development Areas



Appendix B Aquatic Life Use Maps by 12 digit HUC Watershed

Aquatic Life Use designations per Ohio Administrative Code as of September 2009.

- Town of Willoughby-Chagrin River (Lower Branch of Chagrin River)
- East Branch-Chagrin River (East Branch of Chagrin River)
- Griswold Creek-Chagrin River (Main Stem of Chagrin River)
- Beaver Creek-Chagrin River (Upper Main Branch of Chagrin River)
- Silver Creek
- McFarland Creek-Aurora Branch (Lower Aurora Branch and McFarland Creek)
- Headwaters Aurora Branch (Upper Aurora Branch)

Figure 83: Town of Willoughby-Chagrin River Aquatic Life Use

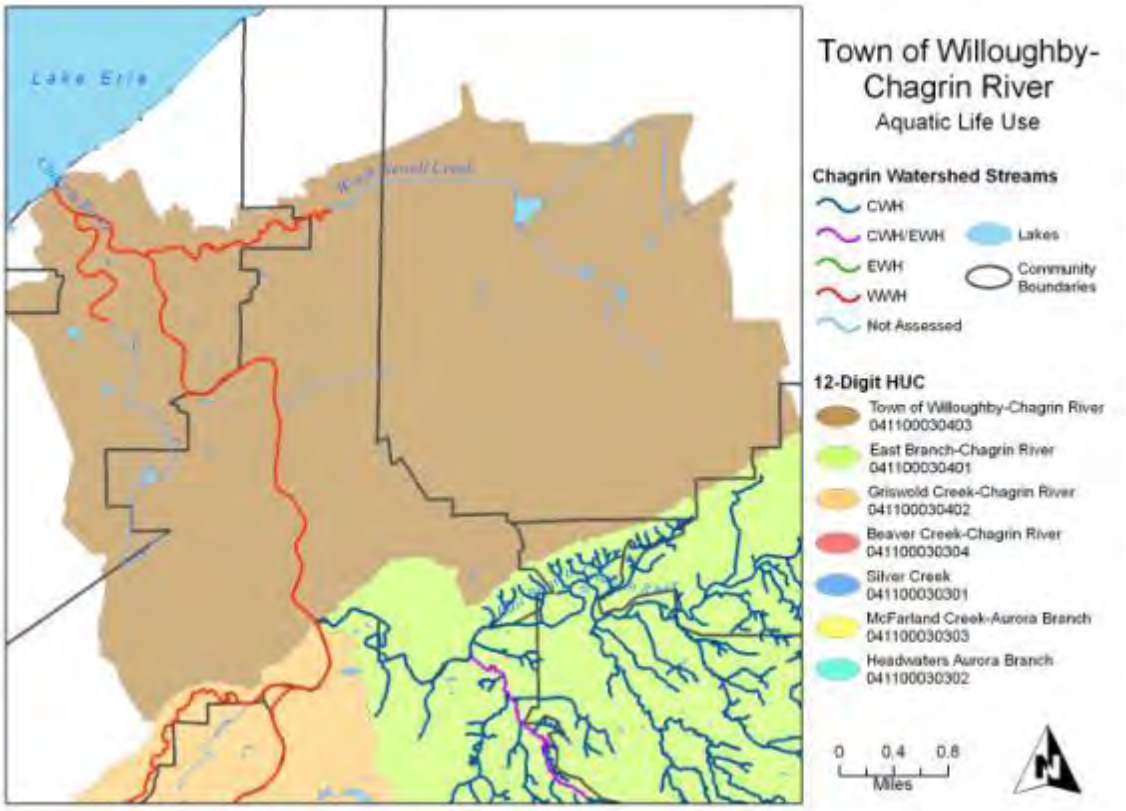


Figure 84: East Branch-Chagrin River Aquatic Life Use

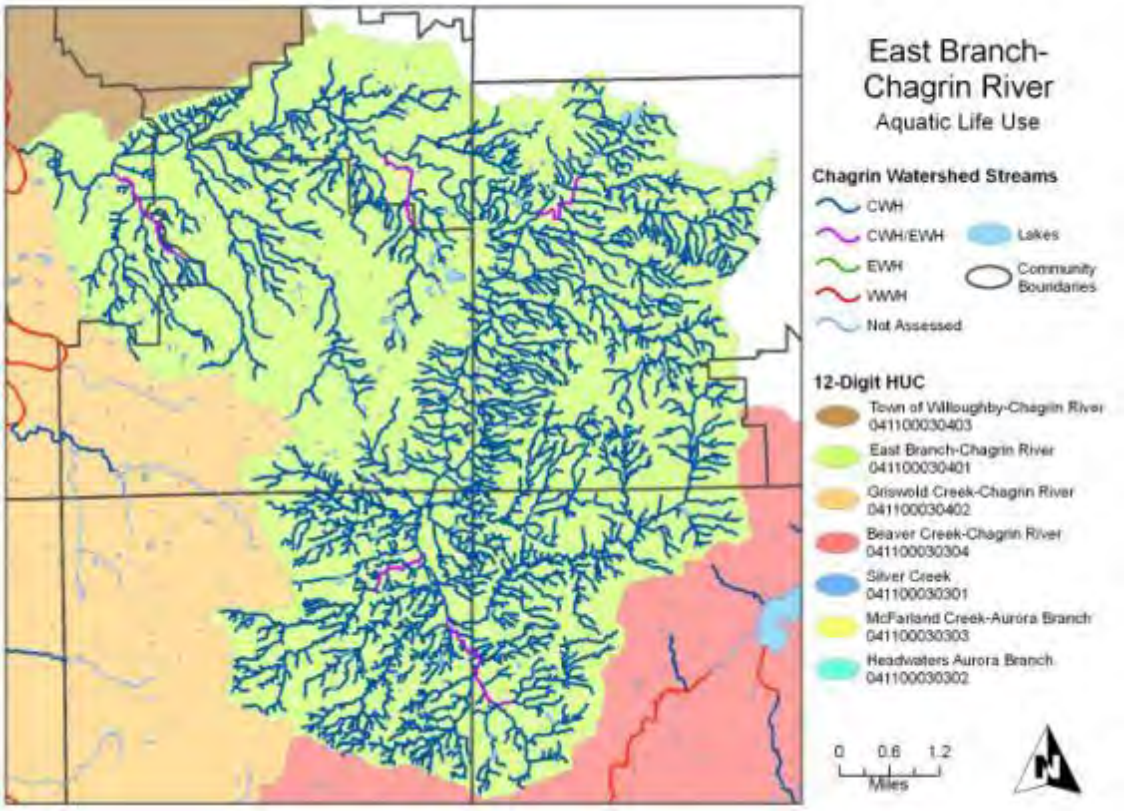


Figure 85: Griswold Creek-Chagrin River Aquatic Life Use

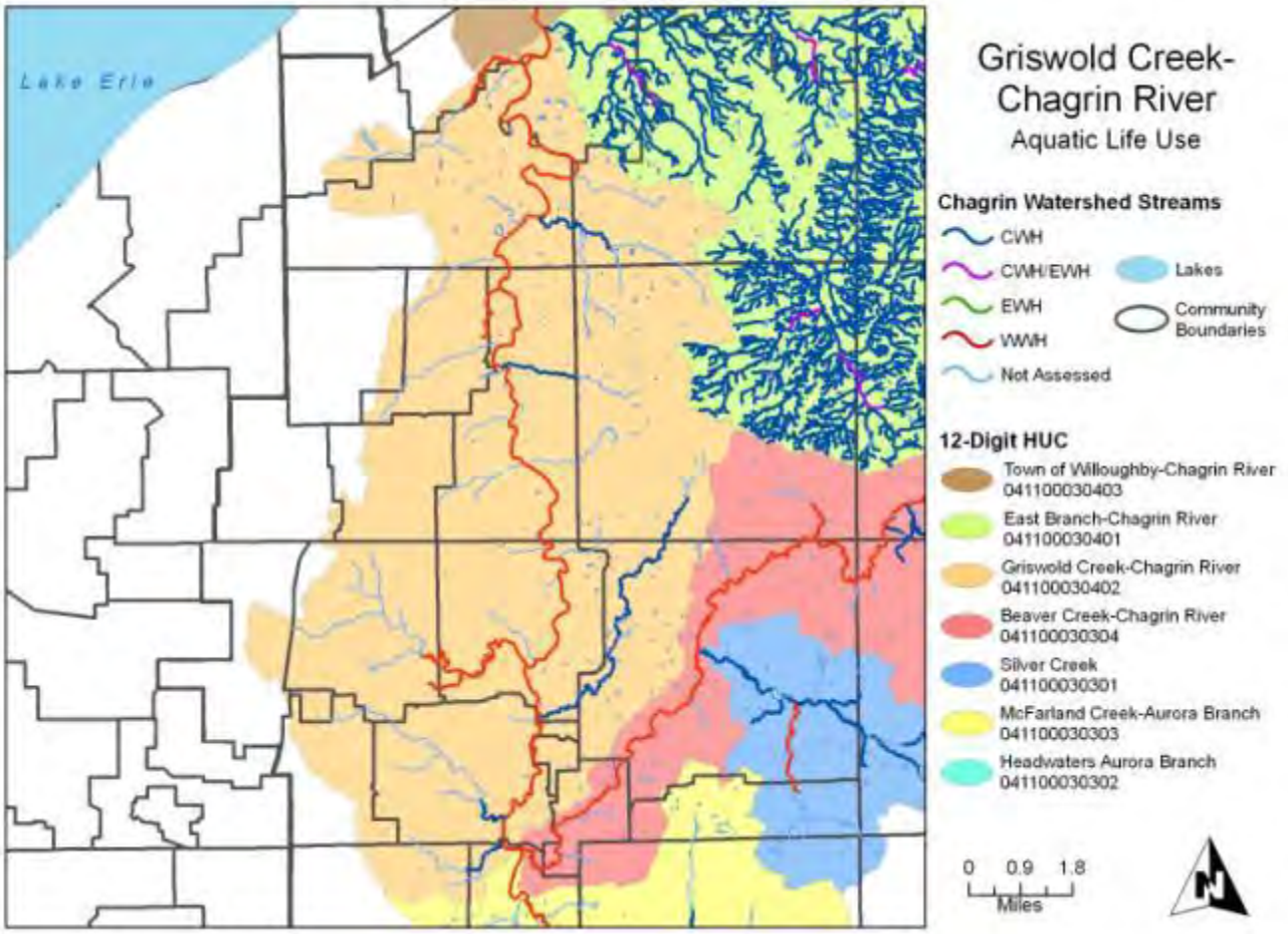


Figure 86: Beaver Creek-Chagrin River Aquatic Life Use

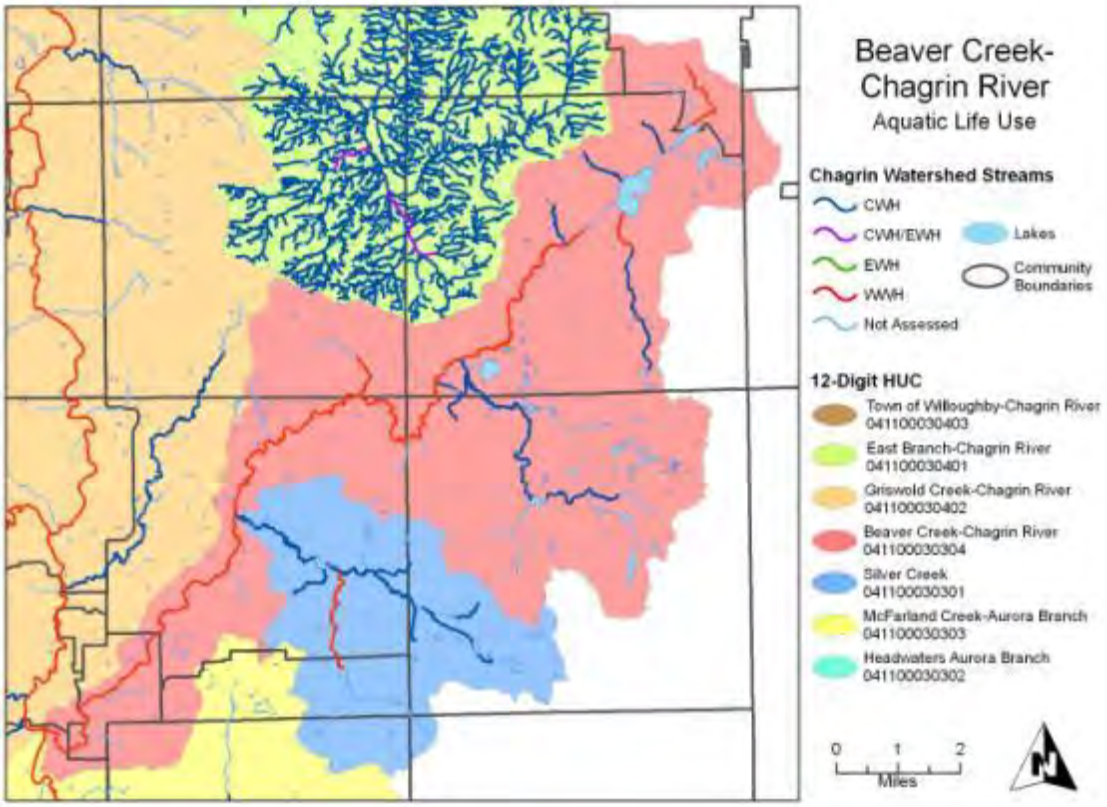


Figure 87: Silver Creek Aquatic Life Use

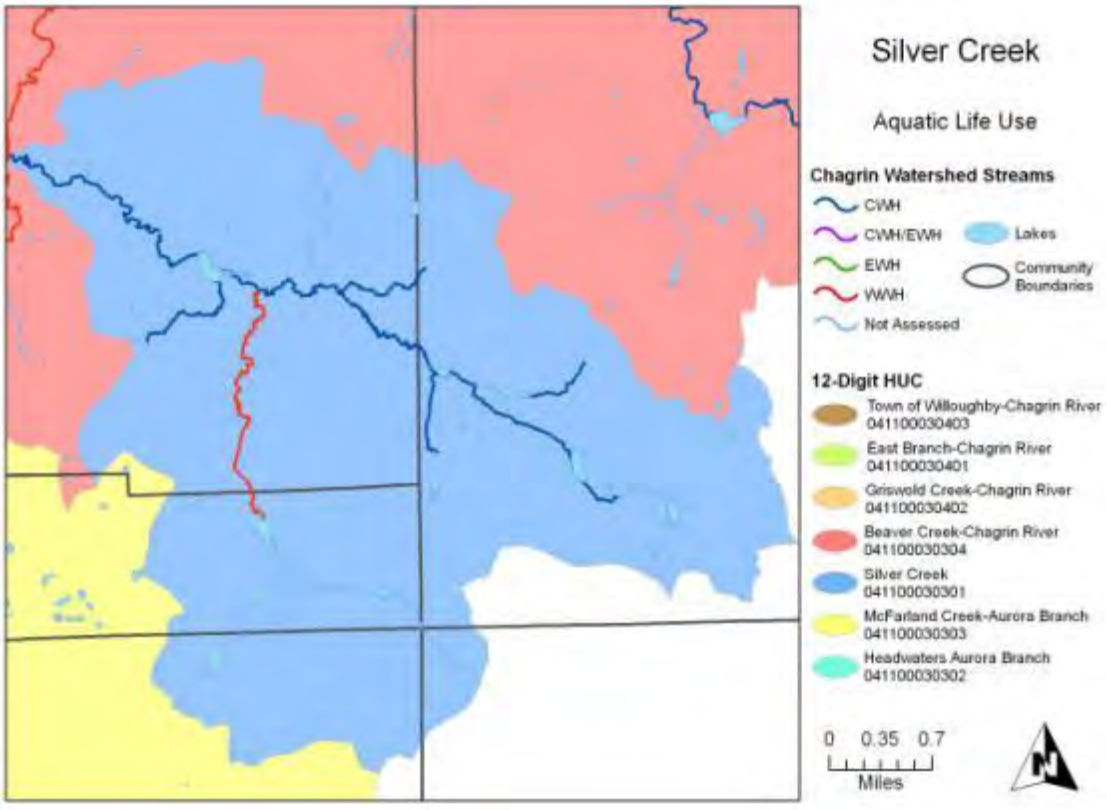


Figure 88: McFarland Creek-Aurora Branch Aquatic Life Use

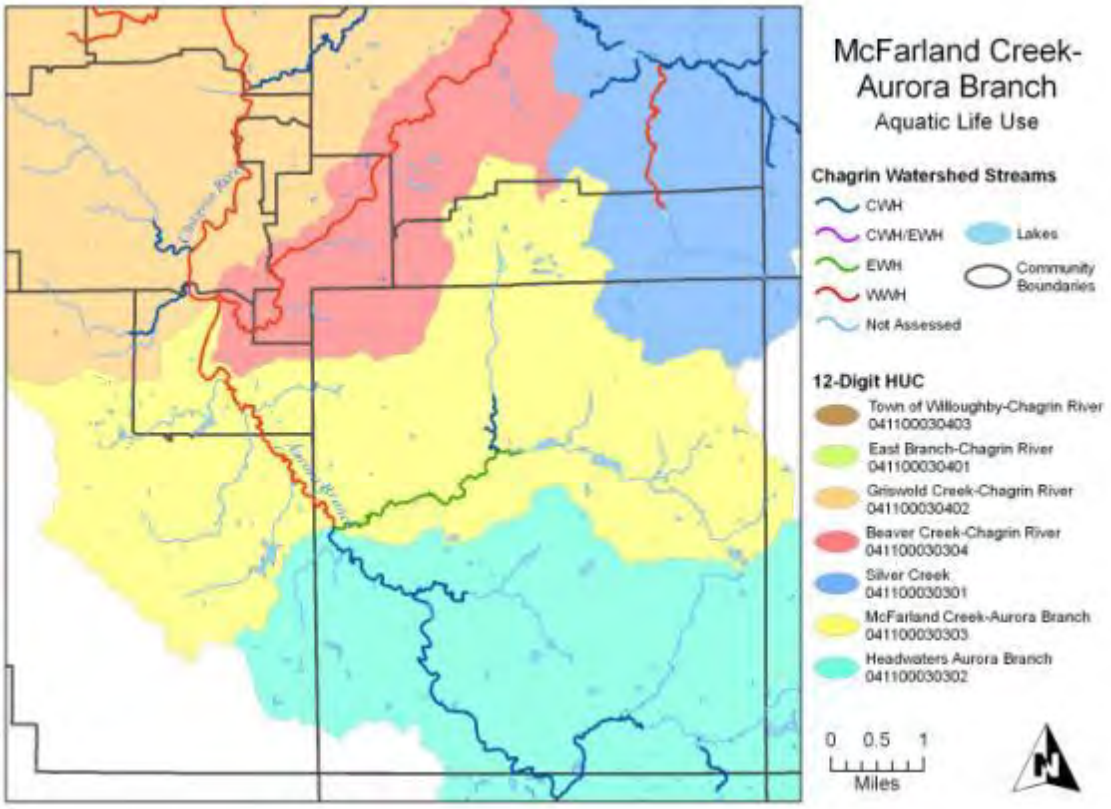
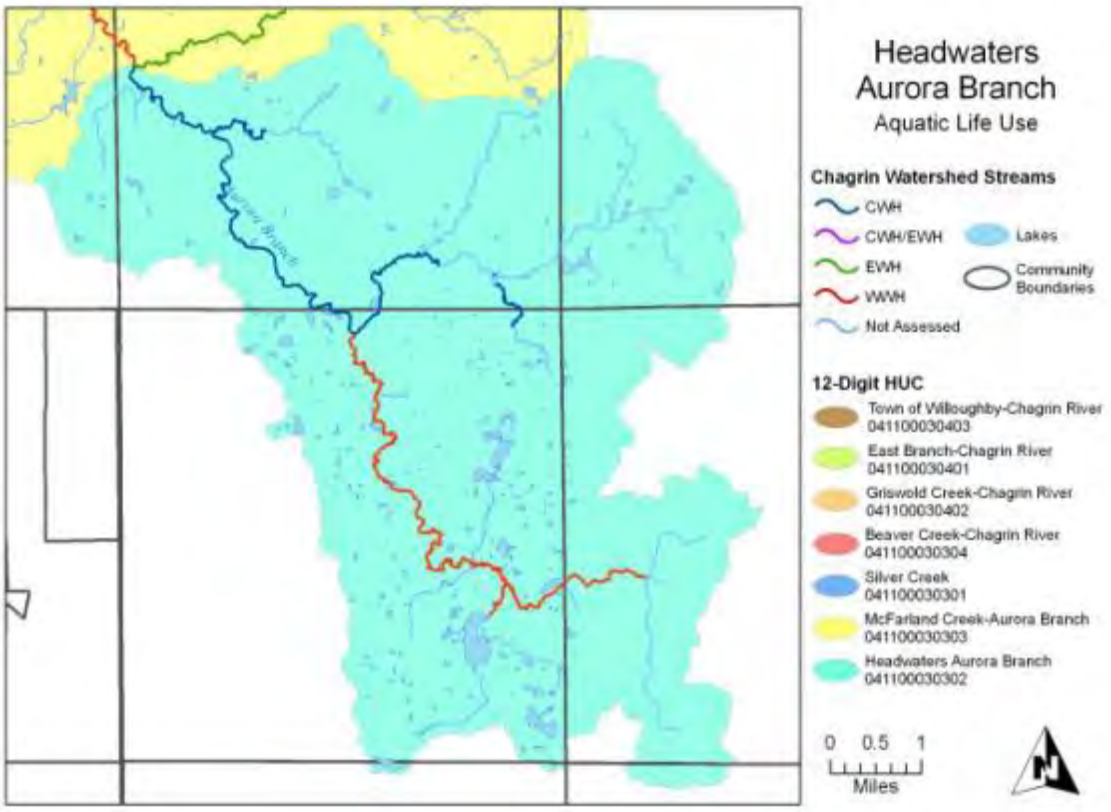


Figure 89: Headwaters Aurora Branch Aquatic Life Use



Appendix C Attainment of Aquatic Life Use Maps by 12 digit HUC Watershed

Aquatic Life Use designations per Ohio Administrative Code as of September 2009.

- Town of Willoughby-Chagrin River (Lower Branch of Chagrin River)
- East Branch-Chagrin River (East Branch of Chagrin River)
- Griswold Creek-Chagrin River (Main Stem of Chagrin River)
- Beaver Creek-Chagrin River (Upper Main Branch of Chagrin River)
- Silver Creek
- McFarland Creek-Aurora Branch (Lower Aurora Branch and McFarland Creek)
- Headwaters Aurora Branch (Upper Aurora Branch)

Figure 90: Town of Willoughby-Chagrin River Attainment Status

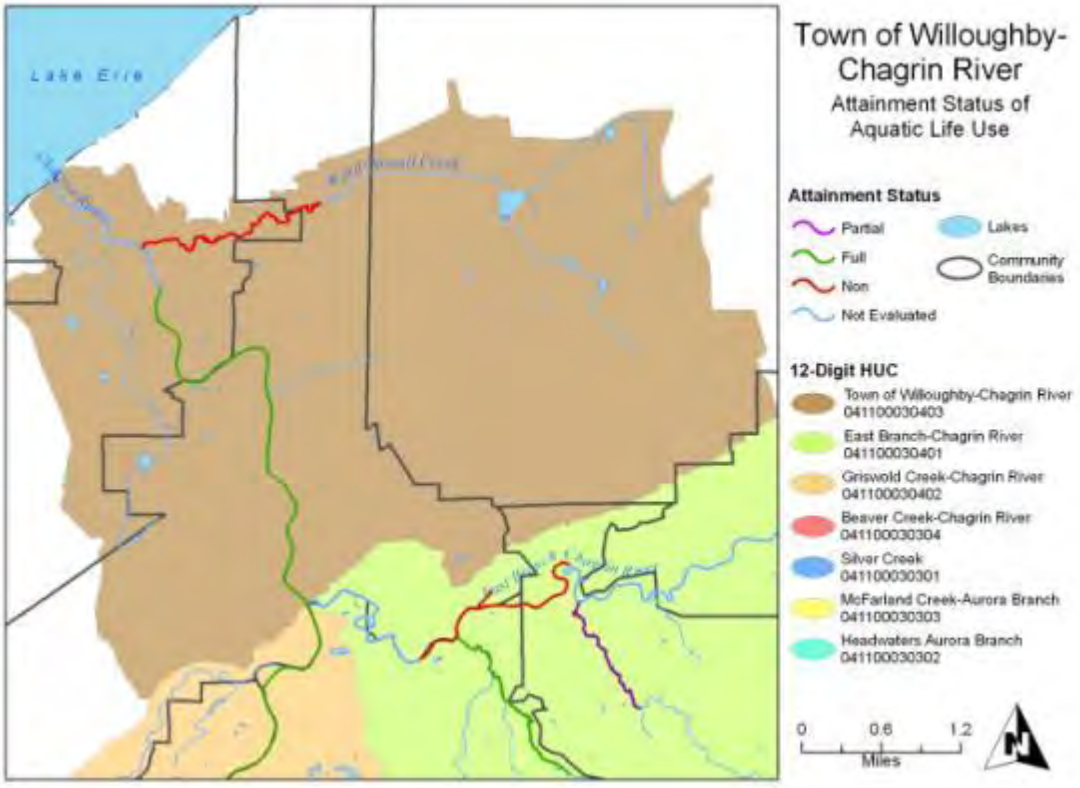


Figure 91: East Branch-Chagrin River Attainment Status

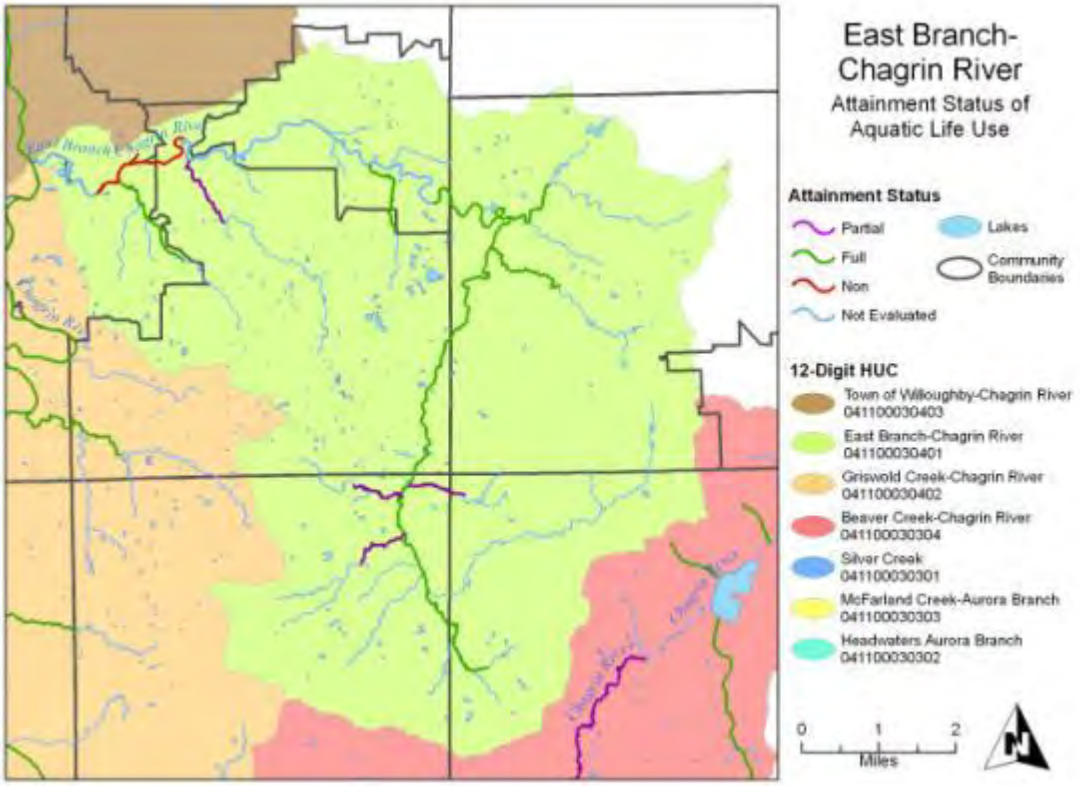


Figure 92: Griswold Creek-Chagrin River Attainment Status

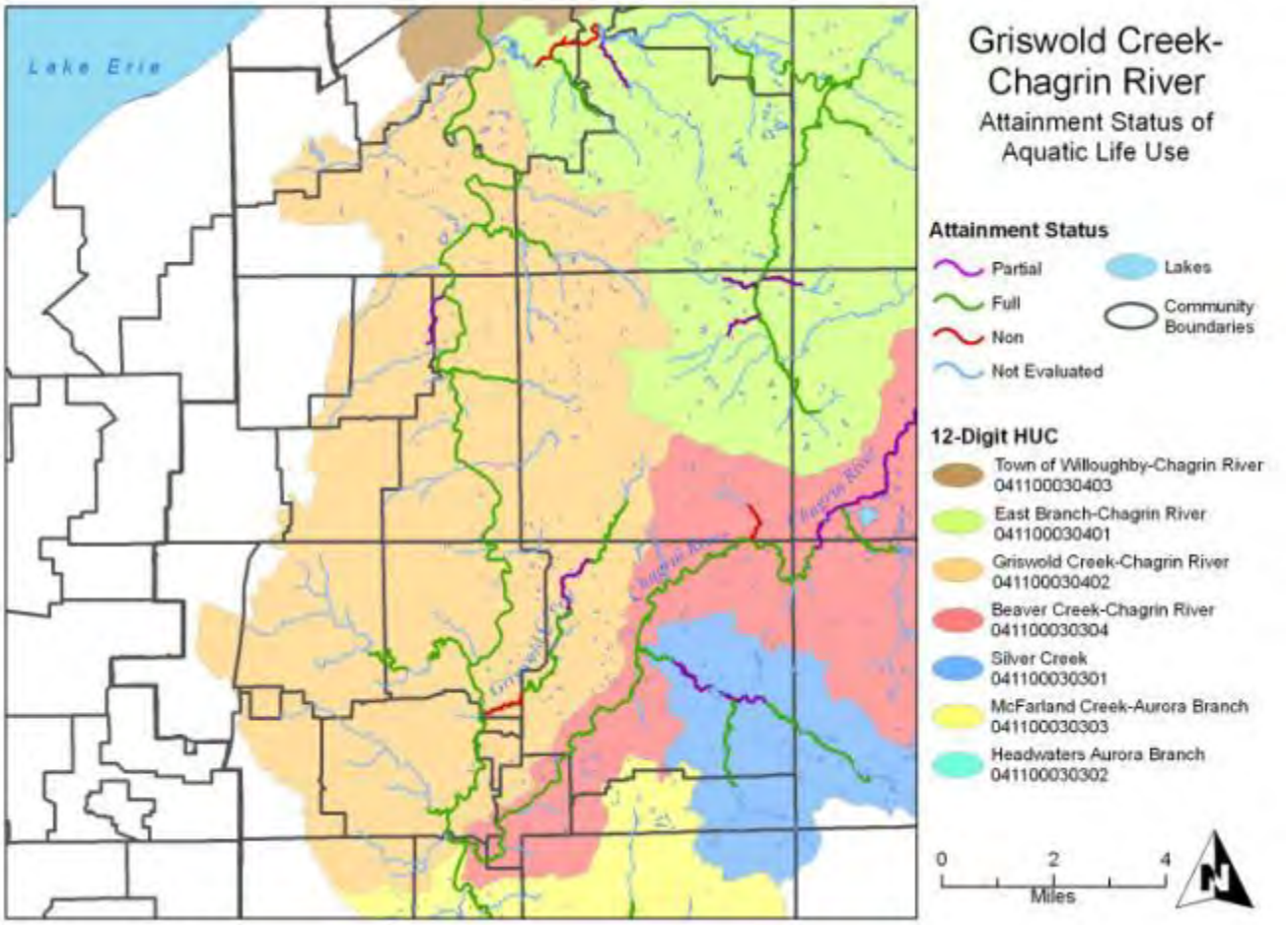


Figure 93: Beaver Creek-Chagrin River Attainment Status

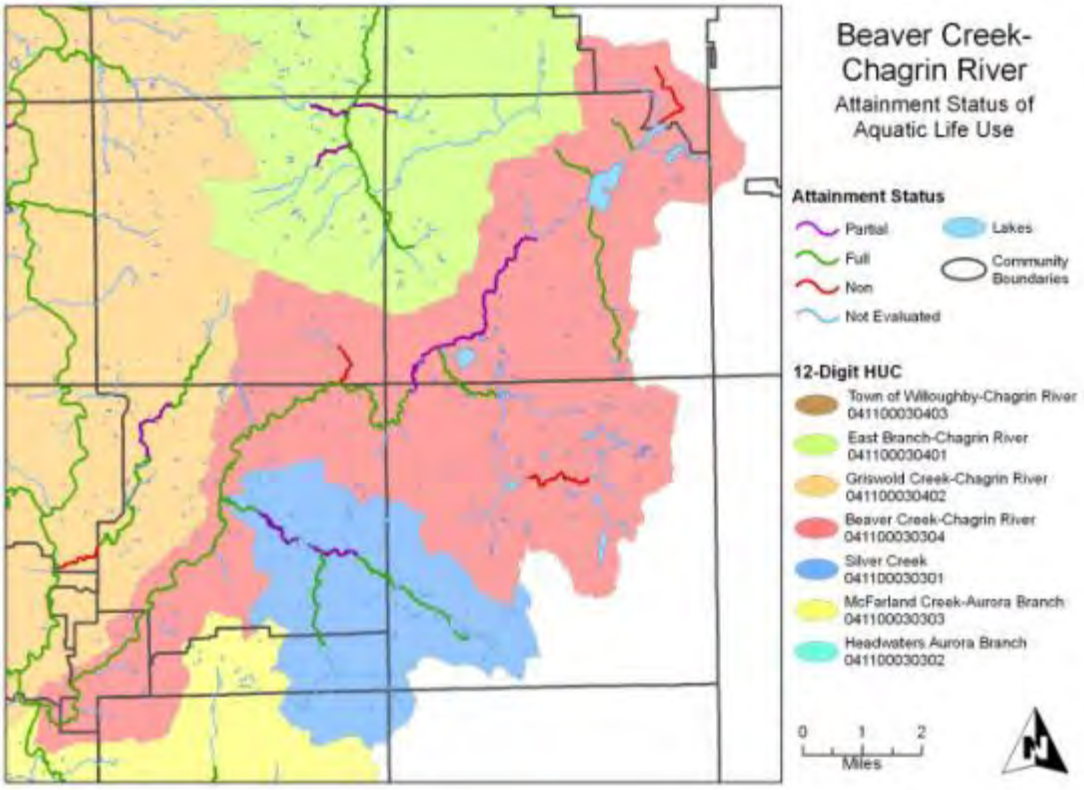


Figure 94: Silver Creek Attainment Status

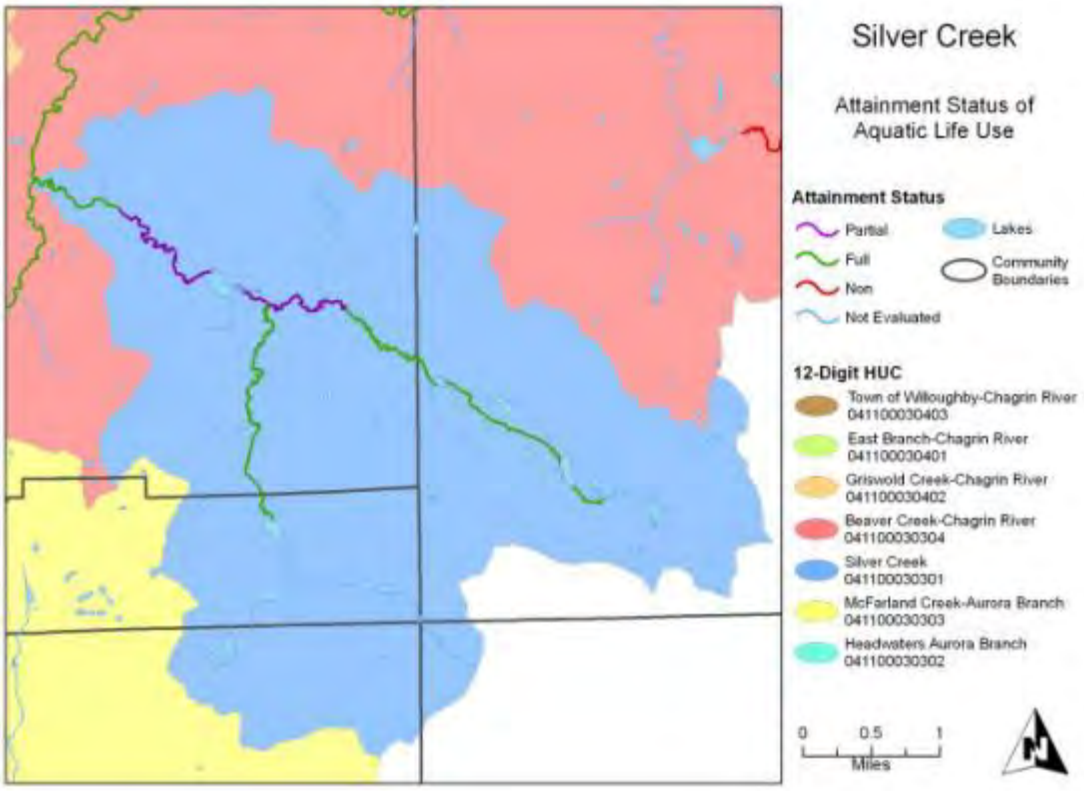


Figure 95: Lower Aurora Branch and McFarland CreekMcFarland Creek-Aurora Branch Attainment Status

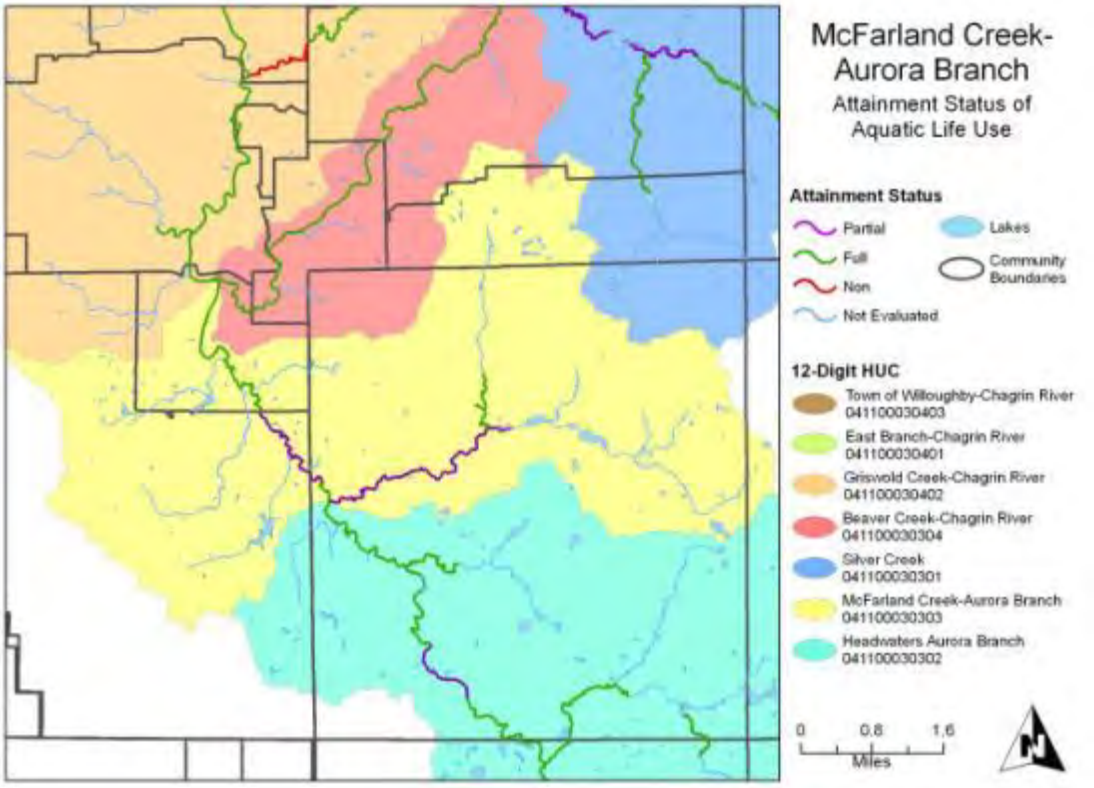
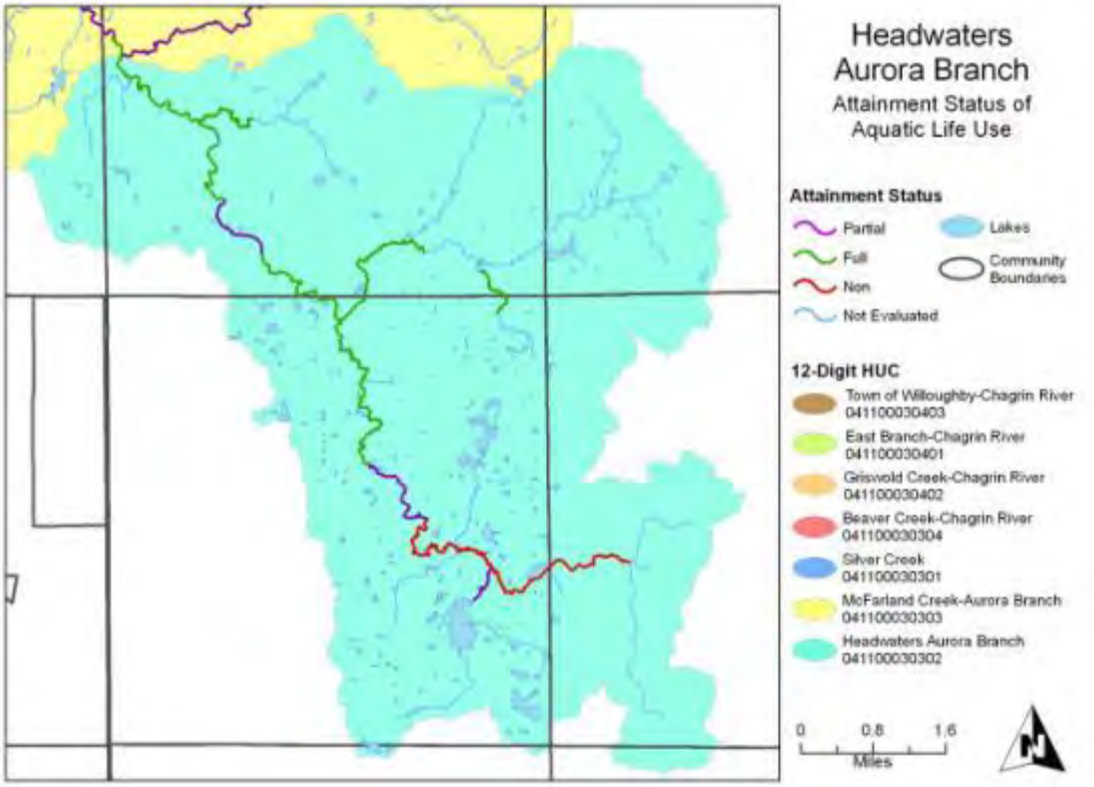


Figure 96: Headwaters Aurora Branch Attainment Status



Appendix D Subwatershed Maps as referenced in Section 11

- Town of Willoughby-Chagrin River (Lower Branch of Chagrin River)
- East Branch-Chagrin River (East Branch of Chagrin River)
- Griswold Creek-Chagrin River (Main Stem of Chagrin River)
- Beaver Creek-Chagrin River (Upper Main Branch of Chagrin River)
- Silver Creek
- McFarland Creek-Aurora Branch (Lower Aurora Branch and McFarland Creek)
- Headwaters Aurora Branch (Upper Aurora Branch)

Figure 97: Town of Willoughby-Chagrin River Subwatershed Maps

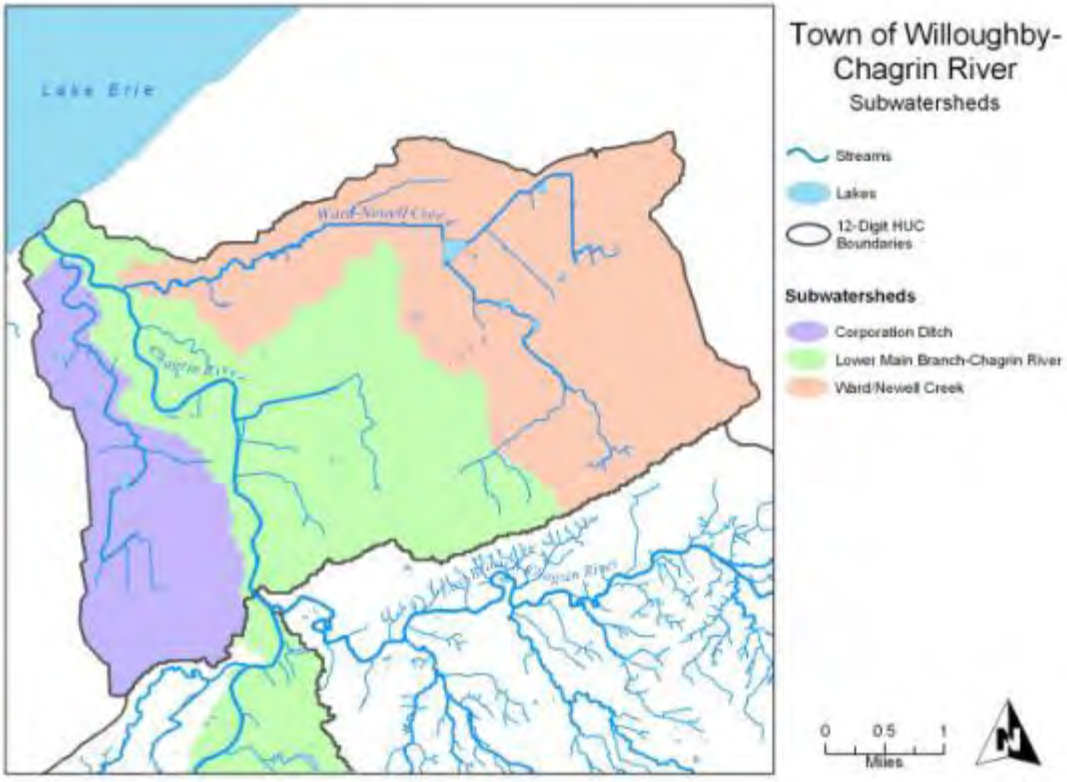


Figure 98: East Branch-Chagrin River Subwatershed Maps

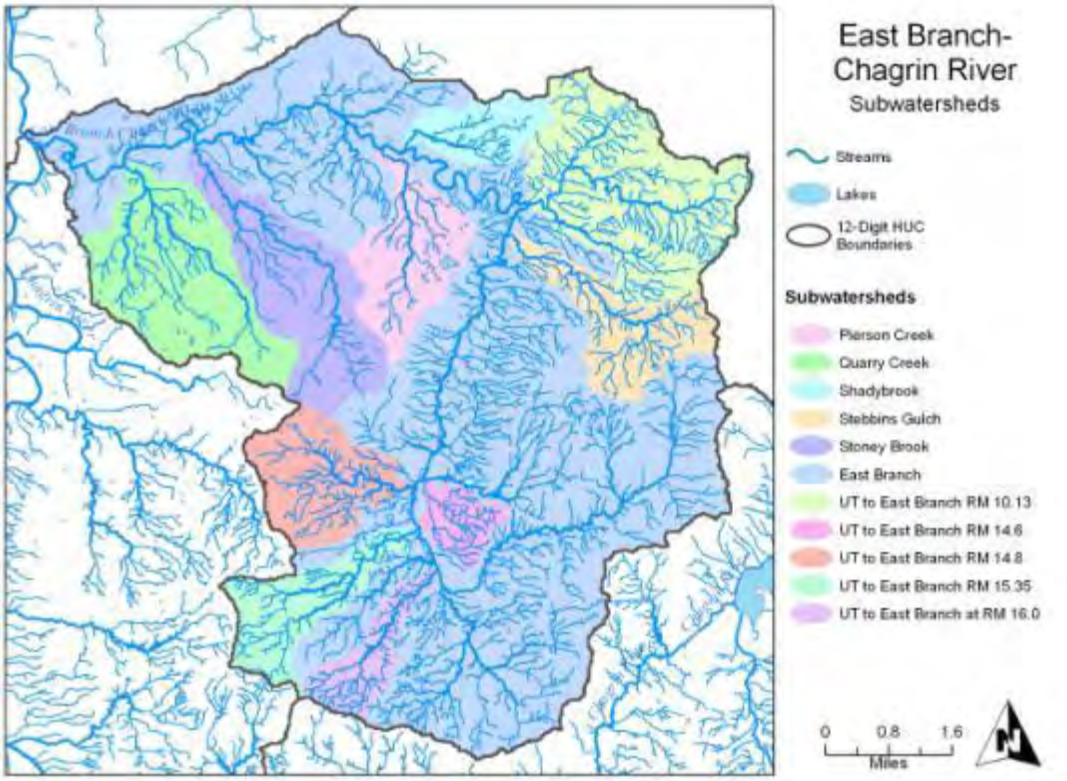


Figure 99: Griswold Creek-Chagrin River Subwatershed Maps

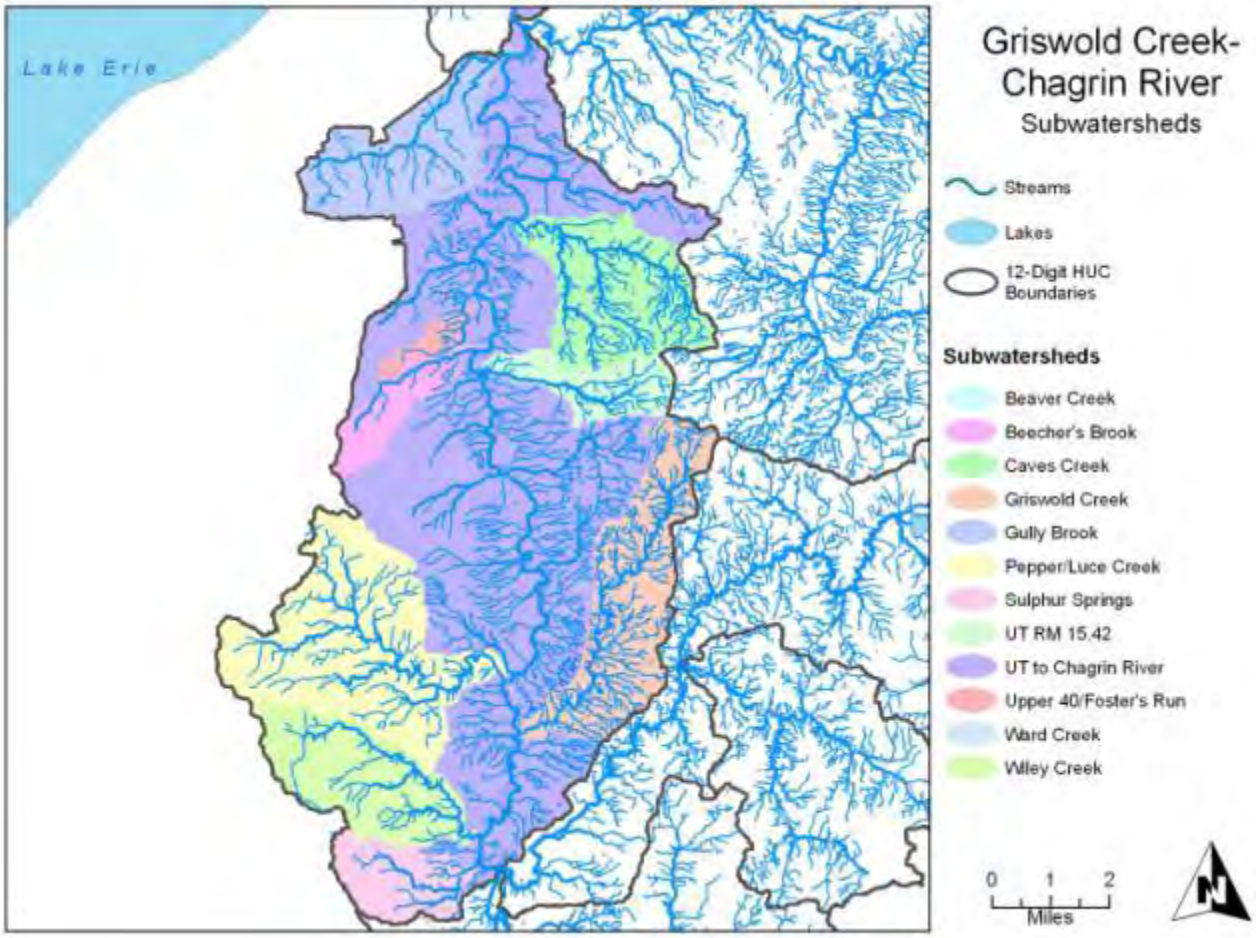


Figure 100: Beaver Creek-Chagrin River of Chagrin Subwatershed Maps

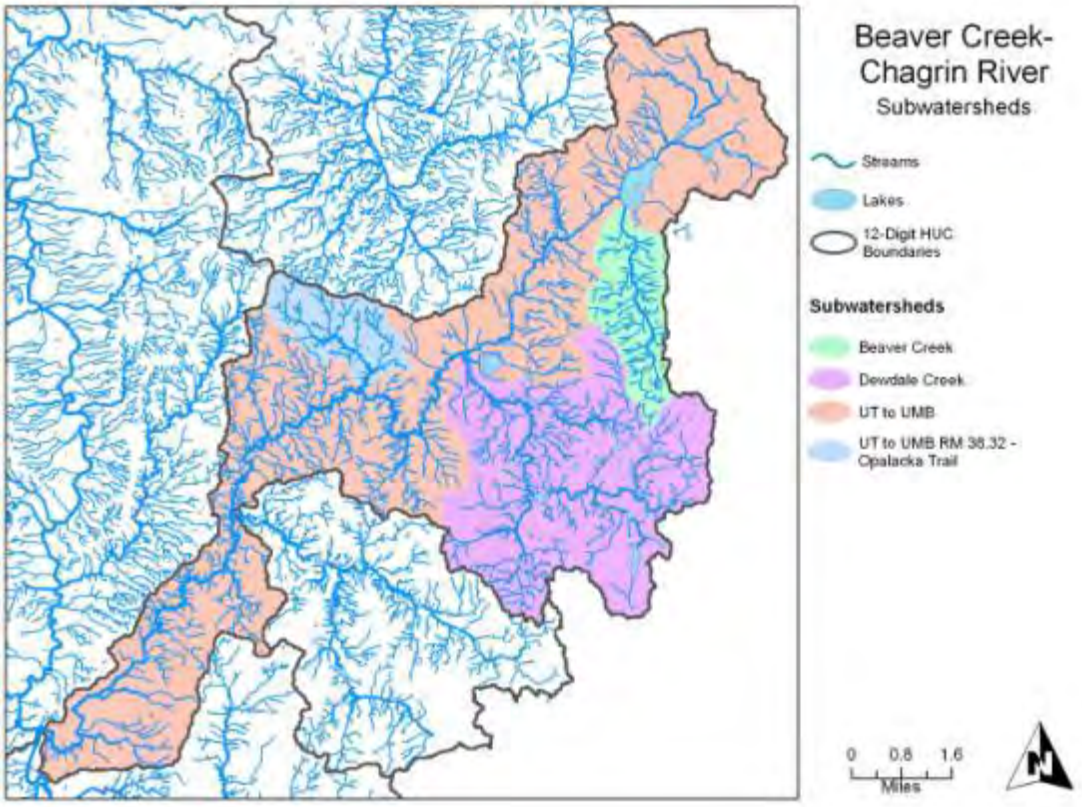


Figure 101: Silver Creek Subwatershed Map

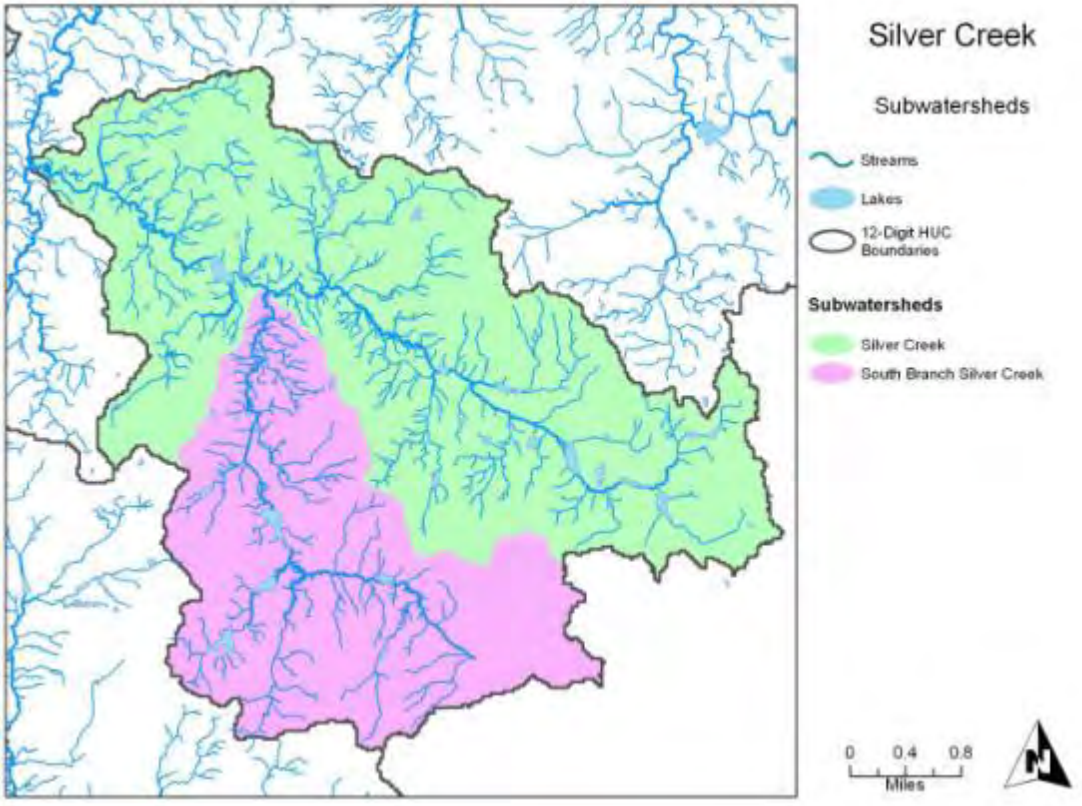


Figure 102: McFarland Creek-Aurora Branch Subwatershed Map

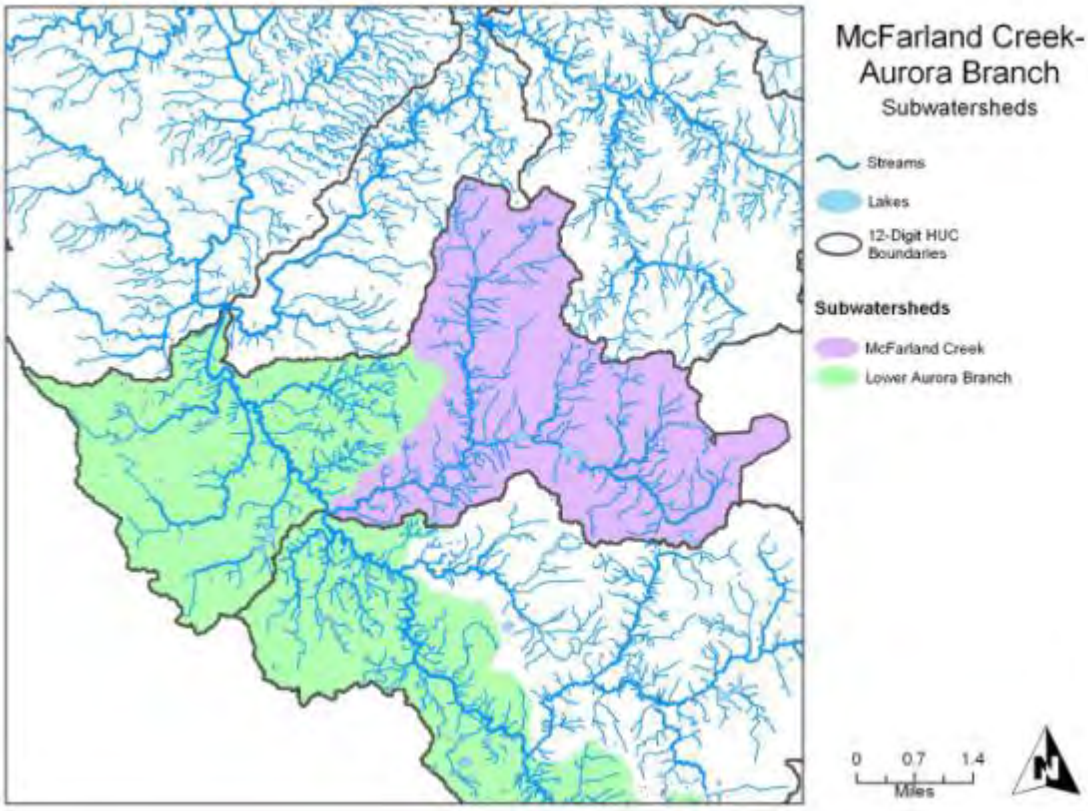


Figure 103: Headwaters Aurora Branch Subwatershed Map